



Innovate to Differentiate.



Product Overview Catalogue



UNCOMPROMISING FOCUS ON QDPICS

Quality • Delivery • People • Innovation • Customer Service

Sierra CP Engineering Ltd.

UK: +44 (0) 1684 584 850 / USA: +1 (0) 517 669 0514

India: +91 8600 148 055 / China: +86 10 6059 3951

www.sierra-cp.com / info@sierra-cp.com

We Specialize in Flexibility



Thirty years of successfully meeting tough customer challenges has taught us at Sierra CP Engineering that the concept of “one solution fits all” just doesn’t work in the auto test industry. As a result, we have positioned our company to embrace the critical role that flexibility plays at every stage of design and development. And it all starts with creating an open atmosphere for client interaction that breeds innovation.

Whether upgrading existing test cells or planning new installations, Sierra CP works in partnership with global clients to develop custom products and systems or provide complete turnkey focused on matching the customer requirements of today with tomorrow’s needs to guarantee a solution that can expand with the test of time.

To help meet the challenges of a rapidly changing industry, Sierra CP has developed advanced hardware and software solutions covering the complete scope of test applications. Innovative, open design and a common, easy to use interface allows us to integrate seamlessly with existing instrumentation and other manufacturers’ equipment, or build powerful turnkey systems designed to our customers’ specific requirements.

At the heart of many Sierra CP solutions is our powerful CADET automation technology, which combines accurate multi-channel control and high-speed data acquisition to deliver optimised solutions for engine, powertrain, emissions and component test rig applications.

Headquartered in the UK, Sierra CP designs and manufactures all our own solutions and supports them globally with technical locations in the USA, China, India and Malaysia.

Sierra Core Values

Every one of our customer solutions is built on an Uncompromising Focus on Quality, Delivery, People, Innovation and Customer Service; our core values. We believe that by always staying true to QDPICS during every project, we will build highly creative and productive relationships with customers that endure.

Visit www.sierra-cp.com for more information.



Lansing, Michigan / USA



Monterey, California / USA

Contents

INTRODUCTION TO SIERRA CP TECHNOLOGY	6
Engine Testing Overview	7
Vehicle Testing Overview	8
Powertrain and E Motor Testing Overview	9
In Cell Support Products Overview	10
CADET V14	11
CADET Edge	17
CADET V14 Compact	21
TLS – Test Laboratory System	27
IN CELL EQUIPMENT	33
Dynamometers.....	35
Valve Manifold and Cooling Post	41
Mechanical Throttle Actuator	45
Exhaust Back Pressure and Air Valves.....	49
AirTrak.....	55
ExhaustTrak.....	59
FUEL SYSTEMS	65
FuelTrak 1000 & 3000	67
FuelTrak Transient 100 & 300	73
Fuel Conditioning Units 1000 & 3000	79
Fuel Pressure Regulation.....	83
Fuel Dosing Rig.....	87
Independent Fuel Controller	91
TEST CELL SERVICES.....	95
Combustion Air Handling Unit (CAHU).....	97
Ventilation Systems.....	105
Test Cell and Facility Services.....	109
Transient Single Cylinder Test Systems	113
VEHICLE TESTING SYSTEMS	125
Chassis Dynamometers	127
Motorcycle Chassis Dynamometer	133
Vehicle Robot	139
EMISSIONS PARTICULATE MEASUREMENT EQUIPMENT.....	145
BG3.....	147
SootTrak	155
BG3 Particulate Sampling Support Equipment	159

INTRODUCTION TO SIERRA CP TECHNOLOGY

The CADET control system has been installed in test facilities worldwide, providing full control and data logging capability to the engine and vehicle testing market. Both hardware and software has been designed and developed specifically for engine and vehicle testing, it is all manufactured, written and tested in-house.

CADET V14 is a constantly evolving software package which is designed specifically to meet the needs of engine and vehicle testing. Sierra CP provide two general enhancement releases every year, these are free to customers on our Service Contracts Scheme. Some of the benefits of CADET V14 are below:



- Over 1000 physical datalogging channels supported
- Multi-screen user interface
- On-line editing of tests, calibration procedures, PID channels
- Drag and drop User Display creation.

CADET V14 utilises Direct Digital Control, to provide absolute real-time operation on a Windows 7 platform, through our dedicated I/O Control and Monitoring System called CP128. CADET V14 will enable operational personnel to easily compile test programs, automatically protect the bed against out of limits operation, record data during the test and analyse the data during or at the completion of the test. The core software is written in C++, with user interfaces written in Visual Basic, custom functions can be developed by the test engineer to run during the test, these can provide additional calculated data that is stored together with real data from the test bed.

Data processing is performed on CP128 rather than by the system computer. All the CP128 cards are driven by a common interrupt signal that allows time aligned averaged data to be captured, rather than sequential snapshot data. Additionally, all channels are optically isolated. This enables Sierra CP to offer a high resolution and reduce the chance of monitoring noise levels.

Sierra CP Engineering policy is one of continual development for both hardware and software. As any changes are designed with existing systems in mind, older systems can easily be upgraded to the latest technology, either by exchanging cards and/or minimal system modification, to ensure backwards compatibility. By designing dedicated hardware rather than using proprietary equipment, Sierra CP provide a test system designed specifically for automotive testing purposes. The current specification has evolved to the latest generation with input from our own engineers and by working closely with our many users.

- Sierra CP design and manufacture all hardware – full control
- Backward compatible - Any Developments consider requirement for existing users
- Designed for engine testing with integrated protection features

Sierra CP Engineering can therefore control all future developments and designs for future customer requirements as well as safeguard support and provide upgrade routes for existing customers.

ENGINE TESTING OVERVIEW



Sierra CP can supply and interface to a wide range of dynamometers for steady state, transient, highly dynamic testing and vehicle simulation, including AC, DC, Eddy Current and Hydraulic. The range of applications includes:

- Emissions and Fuel Consumption
- Endurance
- Performance tests
- Noise Vibration and Harshness
- Climatic
- Quality Audit
- Auxiliary unit
- Special Purpose

VEHICLE TESTING OVERVIEW



Sierra CP can supply for chassis dynamometers for passenger cars, motorcycle, SUV, MPV, LDV, MDV, HDV and off road vehicles. The range of applications includes:

- Emissions and Fuel Consumption
- Mileage Accumulation and Endurance
- Performance tests
- Noise Vibration and Harshness
- Climatic
- Wind Tunnel
- Quality Audit
- EMC
- Flat belt dynamometer
- Tracked vehicle dynamometer
- Special Purpose

POWERTRAIN AND E MOTOR TESTING OVERVIEW



Sierra CP can supply powertrain test solutions from single gearbox, engine and transmission units to full 4x4 as installed in vehicle test solutions. The range of applications includes:

- Emissions and Fuel Consumption
- E-motor and hybrid unit testing
- Endurance
- Performance tests
- Noise Vibration and Harshness
- Climatic
- Quality Audit
- Special Purpose

IN CELL SUPPORT PRODUCTS OVERVIEW



Sierra CP supply peripheral support items for in-cell use including:

- Fuel measurement and conditioning
- Engine coolant, lubrication, intercooler fluid temperature control
- Combustion air handling for temperature, humidity and pressure control
- Extensive data acquisition
- Vehicle cooling fans
- Robot driver
- Tyre burst detectors
- Vehicle retention
- Extensive interfaces for third party equipment
- Emissions sampling and reporting hardware and software

Innovate to Differentiate.



CADET V14

Control, Automation and Datalogging for Automotive Test

Issue 4.1

More detailed CADET hardware and software documentation is available on request. Please contact Sierra CP for further details.

INTRODUCTION

CADET is Sierra CPs in house designed hardware and software, specifically designed for the automotive testing industry. The CADET software has been extensively developed over the last 20+ years, to include the latest features demanded by the automotive test community. The latest release of CADET software is currently V14.4a.

CADET V14 utilises Direct Digital Control, to provide real-time operation on a Windows 7 platform, through our dedicated I/O Control and Monitoring System. CADET V14 enables operational personnel to easily compile test programs, automatically protect the bed against out of limits operation, record data during testing and analyse the data during or at the completion of the test.



Custom functions can be developed by the test engineer (using Visual Basic) to run during the test, these can provide additional calculated data that is stored together with real data from the test bed.

Data processing is performed on the CADET hardware rather than by the system computer. All the control and datalogging cards are driven by a common interrupt signal that allows time aligned averaged data to be captured, rather than sequential snapshot data. Additionally, all channels are optically isolated. This enables CADET to offer a high resolution and reduce the chance of monitoring noise levels.

Sierra CP Engineering policy is one of continual development for both hardware and software. As any changes are designed with existing systems in mind, older systems can easily be upgraded to the latest technology, either by exchanging cards and/or minimal system modification. All service contract holders are entitled to the latest release of the CADET software for free, which generally has two releases a year.

By designing dedicated hardware rather than using proprietary equipment, Sierra CP provide a test system designed specifically for engine and vehicle testing purposes. The current specification has evolved to the latest generation with input from our own engineers and by working closely with our many users. Sierra CP design and manufacture all hardware and write all software in house, so maintain full control of the supply and development chain.

SPECIFICATION

The maximum capability of the current build of CADET (V14.4) is detailed in the table below:

Description	Maximum Channel Count, V14.4
Physical Input	1028*
Physical Output	128*
Digital Input	256*
Digital Output	256*
Primary Setpoints	2
Secondary Setpoints	60
PIDs	64
Logical Channels	2048
User Variables	2000
Independently controlled dynamometers	10*
Control Functions	32
Pseudo Variable Calculations	64
Hardware Protection Channels	24
ASAP-3 Monitored Channels	200*
ASAP-3 Set Points	50*
CAN Ports	8*
CAN Variables – Per Port	300

*Channel counts depend on the CADET hardware installed. CADET systems will be built to the channel count required by the customer.

The major features of CADET V14.4 and the available software interfaces are detailed below, text in *italics* denotes that the component is available as an option.

Standard Sierra CP CADET User Interfaces		
Values display tab	Instrumentation display tab	Digital input display tab
Trakker display tab	User display tabs	Calibration functionality
PID tuning functionality	Test history/datalog manager	<i>Test manager (TLS interface)</i>
Standard Sierra CP CADET Tools		
Calibration history	Test scheduler editor	Transient scheduler editor
Test schedule up-grader	Test stage control	Test schedule sequencing
Transient scheduler	Datalog exporter	Datalog to CSV exporter
TRACE	Trace To CSV exporter	Data archiver
<i>TTAS (Transmission Shift test)</i>	<i>TLS (Regulatory calcs)</i>	
Engine Mapping and Modelling		
<i>Sierra CP VSIM</i>	<i>Sierra CP iCAM</i>	<i>Sierra CP TVS mapper</i>
CADET Interfaces		
CADET Hardware	<i>CAN</i>	Ethernet TCP/IP & UDP
Serial (RS232/RS422/RS285)	<i>GPIB</i>	<i>Modbus</i>
<i>Profibus DP</i>		

Application Protocols		
ASAP-3	ASAP CCP DAQ functions	J1939 DTC functions
OBD II	AK protocols	MATLAB
Sierra CP Cell Services		
Emissions Equipment Interfaces		
Horiba Mexa 6000 Series	Horiba Mexa 7000 Series	Horiba Mexa 9000 Series
Horiba EXSA 1500	AVL AMA i60	AVL SESAM i60 FT
Fischer Rosemount NGA 2000	Signal Instruments series 3	Signal Instruments series 4
Sierra CP Emissions bench controller		
CVS Interfaces		
Horiba 9000 series	Horiba 7000 series	Signal Instruments
Fischer Rosemount	Pierburg PSE 2000 series	Sierra CP CVS controller
Combustion Analysis and Ignition Timing		
AVL 620 Indiset	AVL 647 Indiskop	Sierra CP iCAS
IC 5460 ignition controller	Sierra CP EMaCs ignition controller	
Particulate Measurement Interfaces		
Sierra BG-2 and BG-3 particulates	Sierra BG-3 particle counter	AVL-415/415S Smoke meter
AVL 439 Opacity meter	AVL 472 particulates	AVL 489 particle counter
TIS 3790 particle counter	NOVA microtol 4 particulates	Horiba MDLT130xT particulates
Fuel Measurement and Conditioning		
Sierra CP FuelTrak	Sierra CP FuelTrak Transient	Sierra CP Fuel Conditioning Units
AVL 730 Fuel meter	AVL 733 Fuel meter	AVL 722 Fuel Conditioning Unit
Pierburg KMA 4000 Fuel Meter		
Miscellaneous Instrumentation Interfaces		
LA3 Lambda Meter	AVL 442 Blow-by meter	Horiba MEXA 1170 HFID
Horiba MEXA J series portable		
E Motor Testing Interfaces		
AeroVironment PPS	Yokogawa WT series analyser	AVL Battery Simulator
Instrumentation and Rig Systems		
Sierra CP Combustion Air Handling Unit	Sierra BG-2 & BG-3 particulates	Sierra CP Brake test rig
Horiba synthetic catalyst rig	Horiba SIGU synthetic catalyst rig	Oribital synthetic catalyst rig
Sierra CP Transmission Robot		
Chassis Dynamometer Interfaces		
Sierra CP CDS	Burke Porter CDS using AK	Maha CDS using AK
Sierra CP CDS Power checker	Sierra CP Drivers Aid	Sierra CP Tracked vehicle Drivers Aid
Sierra CP NVH	Sierra CP Vehicle Robot	

For further details on any of the specifications listed, please contact Sierra CP.

APPLICATIONS

- Engine test
 - Petrol/Gasoline
 - Diesel
 - LPG and other specialist fuels
 - E Motor and Hybrid
- Vehicle test
 - 2WD up to 8WD
 - Tracked systems
 - Independent rollers
 - Hub mounted systems
- Powertrain testing
- Vehicle robots
- Fuel systems
- Emissions control and testing
- Test cell and facilities control
- Combustion air handling
- Component testing
- Specialist rigs (injectors, pump test etc)
- Production test
- Hot test
- Cold test



Please contact Sierra CP with your specific application requirements for further information on CADET's capability.

OPTIONS

Hardware is custom designed from standard modules to meet the customer's control and datalogging requirements. A CADET questionnaire is available on request to aid with the specification of the CADET channels. Similarly, the CADET software interfaces to 3rd party devices required should be specified on order placement. Please contact Sierra CP for further details. Similarly if special software functions or tests are required then they can be programmed on request.

CADET hardware and software can be upgraded at any time to accommodate additional channels and interfaces. Sierra CP provides backwards compatibility hardware upgrades and continued software upgrade path. An extensive stock of obsolete cards is also kept to support existing customers with older systems. All service contract holders are issued with the latest CADET software updates free of charge, meaning that new features and enhancements are continually introduced in line with the ever changing demands of the automotive test industry.

Innovate to Differentiate.



CADET Edge

Dynamometer and Engine Controller

Issue 4.2

INTRODUCTION



The CADET Edge is part of the CADET range of control systems (see separate datasheet), designed specifically for dynamometer control and engine throttle actuation. The CADET system can actuate eddy current, hydraulic, AC or DC dynamometers and will be supplied with the appropriate power modules.

Control of the dynamometer and throttle is either automatic or manual. When in automatic mode the throttle and dynamometer setpoints follow a pre-programmed test cycle. In manual mode

the throttle and dynamometer setpoints can be adjusted by demand encoders mounted either on the control enclosure (as shown), or a winged keyboard. Alternatively setpoints can be adjusted on the control screen. Setpoints can either be torque, power, speed or direct %, with bumpless transfer between modes at any point during testing. CADET Edge can act as a closed loop dynamometer controller receiving setpoints from a 3rd party host or non real time control software (available as an option, please contact Sierra CP for further details).

The unit is housed in a desk or 4U rack mountable unit, allowing for easy integration into existing test cells. The CADET Edge package includes CADET's software and hardware independent safety systems to ensure safe operation of the dynamometer and engine under test. All control channels and datalogging channels (if selected as an option) can be configured as safety channels on a stage by stage basis. The CADET system can also link into existing cell safety systems, for example E-stop chains, fire suppression systems, test cell doors interlocks etc, via volts free contacts.

An in-cell enclosure is provided, which will provide a marshalling point for the throttle and dynamometer connections. Additional Sierra CP modules can also be integrated into this box, as required. Sierra CP can provide up to 11 channels of user specific datalogging capability. These channels will be displayed on the CADET screen and logged with the key parameters.

The CADET Engine electrics panel can also be integrated into the in-cell box. This allows up to 4 off engine circuits to be switched on and off by CADET, this is generally used for ignition, ECU, fuel pumps, crank etc. Indicator LEDs show activity and resettable fuses protect the circuits. A customer supplied 12/24V battery/power source is required.



BENEFITS AND FEATURES

- Integrates with any dynamometer, new or existing
- Mechanical or electrical throttle actuation
- Compact 4U module with integrated industrial PC
- Manual or automatic control modes
- Integrated software independent safety shutdowns
- Easy to use CADET control software
- 21 point form based calibration system with various 'best fit' options
- PID tuning
- Datalogging options – up to 12 channels
- Trace feature allows power curve generation or multiple channels to be viewed in real time on a single plot

Please see the CADET V14 datasheet for further details on benefits and features.

APPLICATIONS

- Eddy current dynamometers
- Hydraulic dynamometers (1 and 2 valve)
- AC dynamometers
- Gas stands
- Endurance test cycles
- Retro fit existing dynamometers

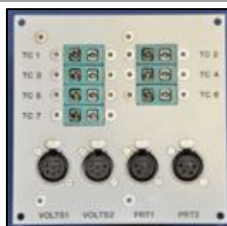
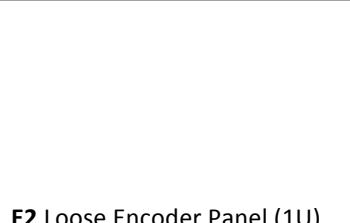
CUSTOMER RESPONSIBILITIES

Normally the customer will be responsible for the following as required:

- Installation (Sierra CP will provide drawings. Sierra CP can quote for this if necessary)
- Monitor with VGA connection, supporting 1024 x 768 pixels (Customer can select this as option H1)
- Fully functional engine for commissioning phase
- Calibration system and weights for commissioning
- Provide Sierra CP with information on the type and model of dynamometer. The dynamometer should have some form of speed pickup and generally a loadcell/torque transducer
- Provide Sierra CP with wiring diagrams/terminal layouts of the dynamometer
- 230/110 V power to control module and in cell enclosure
- 12/24V engine power supply, if Engine Electrics option (D1) is selected

OPTIONS

The dynamometer controller will be supplied with a control enclosure, in-cell box, keyboard and mouse. The dynamometer controller can be specified by selecting one option from each of the rows below. Customer specific options may also be available, please contact Sierra CP.

Dynamometer Type	A1 Eddy Current	A2 Hydraulic – Single Valve	A3 Hydraulic – Double Valves	A4 AC or DC	
Mechanical Throttle Actuation*	B0 Not Required		 B1 AT12 Mechanical Throttle Actuator (See separate datasheet)		
Additional Datalogging (Transducer Panel integrated into in-cell box)	C0 Not Required	 C1 7 Thermocouples, 4 Analogue Inputs	 C2 7 Thermocouples, 2 Analogue Inputs, 2 PRTs	 C3 3 Thermocouples, 8 Analogue Inputs	
Engine Electrics panels (12/24V CADET controlled relay driven circuits)	D0 No Engine Electrics Panel		 D1 Engine Electrics Panels Integrated into in-cell box		
Throttle and Dynamometer Manual Control Encoders	 E1 Encoder Panel Mounted on Control Enclosure		 E2 Loose Encoder Panel (1U) for integration into customer cabinet/desk.		 E3 Sierra CP Winged Keyboard with Integrated Encoders
Enclosure Mounting	F1 4U Rack Mountable Unit		F2 Desktop Case		
Loom Lengths Between Control Enclosure and In Cell Box	G1 2 Metres	G2 5 Metres	G3 10 Metres	G4 15 Metres	G5 20 Metres
CADET Monitor	H0 No Monitor (Customer supplies their own)			H1 19" Flat Screen Monitor	

*Single analogue throttle channel provided as standard

Innovate to Differentiate.



CADET V14 Compact

Starter Control, Automation and Datalogging System

Issue 4.1

INTRODUCTION

CADET-Compact offers an easily expandable solution to meet the needs of educational establishments, smaller companies or those who require accurate dynamometer, engine and coolant control but with limited monitoring channels. CADET Compact uses the same control and data logging system and base structure as the Full CADET V14 systems but with a reduced channel count and associated cost. AC, eddy current or hydraulic dynamometers can be controlled via CADET compact and the associated control modules.

CADET-Compact Modular components are:

- 12U Cabinet including
 - 3U Control rack
 - 3U Datalogging rack with space for expansion
 - System Controller PC
- CADET-Compact Software
- Winged Keyboard Operator Interface
- In Cell Box including
 - 12/24V switched relays (ignition, fuel pumps, ECU etc)
 - Coolant control and feedback connections
 - 12 channel CADET Compact transducer interface panel (various options available)
 - Dynamometer power module (Eddy current or hydraulic)
- AT12 mechanical throttle actuator (Optional - system also support analogue throttle outputs)
- Single 19" monitor



BENEFITS AND FEATURES

- Latest CADET software, not 'previous version'
- Retro fit to existing dynamometers to provide precision control
- Compact Design
- Minimal installation required
- Easily Expandable
- Extensive software and hardware safety features

APPLICATIONS

- Dynamometer and engine test cell control with Protection and limited Data logging
- Durability Work
- Additional Beds to Compliment Other Research Beds
- Initial purchase that can be upgraded to a full CADET system

SYSTEM DESCRIPTION

Cabinet



The CADET-Compact 12U (600mm x 600mm) cabinet houses the two Sierra CP i/o racks and also the rack mounted system controller PC. The cabinet includes all the termination for the control, safety and data-logging sub-systems such as the Engine Protection Panel. Any wiring associated with in-cell equipment is terminated into modules within the cabinet that provide a multi-way connection for onward connection using the supplied looms. The looms have multi-way connectors at each end, which allows easy onsite installation of the cabinet and in cell enclosure.

Operator Interface

The winged keyboard, display, mouse and system control PC are all connected to the CADET-Cabinet by 3m flying leads. The winged keyboard enables the operator to enter test information with the QWERTY keyboard, abort tests using the E-stop mushroom, enter a RESET condition after a shutdown and silence the Alarm. Incremental Optical Encoders allow the operator to take manual control of the throttle and dynamometer setpoints.



CADET Compact V14 Software



At the heart of the CADET-Compact system is the control software, this enables full control of the dynamometer, Throttle Actuator, oil and coolant conditioning circuits as well as monitoring the datalogging channels.

CADET-Compact also allows calculated channels to be created using information from the monitored channels. For test writing CADET-Compact allows transient schedules setpoints to be written in an excel spreadsheet format. Schedules can be looped and

combined and can be called at any time during a test. At any point in the test manual control can be selected, meaning that the engine and dynamometer setpoints can be varied via the winged keyboard.

CADET-Compact uses a reduced functionality version of the full control CADET V14 software. All controls and displays are of the same format meaning all the design benefits of the fully developed version are available. The CADET compact system is limited only in the number of datalogging channels supported and software interfaces to 3rd party instrumentation (such as emissions analysers, Non Sierra CP fuel equipment, CAN & OBD interfaces etc). The system can be upgraded to offer full functionality as necessary.

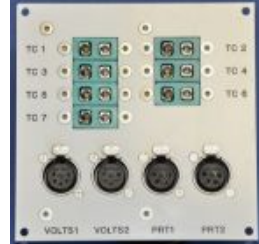
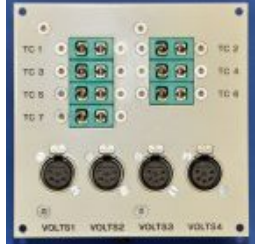
Dynamometer Control and Engine Electrics Box

This in-cell box contains the power modules for the Throttle Actuator and eddy current or hydraulic dynamometer. There are four relay switched low voltage terminals, which switch from a common power source connection such as an in-cell power supply or battery. These can be switched on or off with the associated Digital Outputs during tests. They are typically linked to ECU, Fuel, Glowplugs and Ignition. There are connections for PRT sensors with analogue feedback for PID cooling control of coolant, oil and intercooler circuits. The datalogging transducer panel is mounted within the engine electrics box to allow all termination at a single source. This panel can be re located into a transducer box if the system is expanded in the future. An oil pressure switch is fitted to the bottom of the enclosure.



Transducer Panel

The Sierra CP transducer panel will allow the customer termination for up to 12 datalogging channels, as required. All Sierra CP panels are of a standard size with standard looms, allowing modules to be interchanged and relocated if the system is expanded. The following transducer panels are available for use with the Compact system:

			
7off K Type TC (+CJC) 2off PRT 2off Analogue Inputs	7off K Type TC (+CJC) 4off Analogue Inputs	3off K Type TC (+CJC) 8off Analogue Inputs	12off Analogue Inputs

Analogue inputs can either be voltage (up to 10V) or current (up to 20mA). These inputs can be used as pressure inputs with 4-20mA transducers. All units within CADET are configurable.

Throttle Actuator - Option

The AT12 is an enclosed DC motor driven Throttle Actuator that can form part of the CADET-Compact system. The actuator provides performance suitable for applications ranging from small two stroke engines up to heavy diesels and Racing Engines. Further detail on the AT12 throttle actuator can be found in the relevant datasheet. As standard CADET compact provides one or two analogue output channels which can be configured to give a number of throttle output signals.



OPTIONS

The CADET compact system is of a standard build, meaning that design costs can be kept to a minimum. On order placement the customer should let Sierra CP know the type, make and model of dynamometer being controlled, and select a suitable transducer panel (as detailed previously). The customer should also detail the loom lengths required for installation.

A number of Sierra CP in cell engine test hardware is compatible with CADET compact, further details on these can be found in the associated datasheets:

- FuelTrak 1000 and 3000 gravimetric fuel measurement systems
- FCU 1000 and 3000 fuel temperature conditioning units
- Valve manifold and cooling post, for conditioning of engine circuits
- Air and exhaust back pressure valves

All other Sierra CP equipment, engine interfaces and 3rd party software interfaces can be used with the CADET system once a full CADET V14 licence has been purchased. This also allows the customer to increase the control and datalogging capability as necessary.

CUSTOMER RESPONSIBILITIES

The customer is generally responsible for installing the system (although Sierra CP can quote for this if required). Installation is straightforward: the CADET cabinet and user interface (keyboard, monitor and mouse) are generally installed in the control room. A single in cell box is then installed within the test cell, with looms connecting the cabinet to the in cell box (looms will be pre made to the required length). The AT12 throttle actuator (if purchased) and dynamometer control loom then connects to the in-cell box. Both the CADET cabinet and in cell box require single phase 230/110V power.

Once installation is complete a Sierra CP commissioning engineer will commission the system. The customer should ensure that the dynamometer and all cell services are fully functional. The customer should also provide a functional engine for the commissioning along with dynamometer calibration system and weights.

Innovate to Differentiate.



TLS – Test Laboratory System

Emissions Calculation, Reporting and Test Scheduling

Issue 4.1

Please note: a more detailed specification document on the TLS system is available on request, please contact Sierra CP for further details.

INTRODUCTION

TLS is a software solution developed specifically to support testing of Engines, Vehicles & Components. It integrates seamlessly with the Sierra CP Engineering CADET Automation System to provide a complete solution for configuring & running tests, pre & post test data entry, emissions calculations and report generation. The versatility of the TLS architecture and its data management allows prescribed regulatory tests and custom procedural or manual style testing to be accomplished within a single working environment. TLS fulfils the following roles within the testing environment:

- Centralised Repository stores test and configuration data
- Creating and scheduling test activities
- Operation of testing Process at test cell Automation System host
- Test data input to and extraction/archiving from the test cell Automation System host
- Regulatory emissions calculations and test cycle validation (optional feature)
- Generation of test reports

TLS is a distributed system running on multiple WINDOWS PC platforms connected by Ethernet. All configuration and test data is stored centrally in the TLS Repository server and accessible remotely by the TLS Lab Manager and TLS Cell Manager clients. TLS is configurable to suit the organisational requirements through the use of template definitions which are created and updated by editors within the TLS Lab Manager clients. This allows specific designs for Projects, test Processes and dataset Cards to be implemented and full customisation of Report layouts.

KEY FEATURES

Regulatory Calculations

Standard emissions calculations are available for regulatory authorities such as the EEC, ECE, EPA, INDIAN, ISO and CARB. Calculations are automatically performed on the test data at the completion of the test Process and results are immediately viewable online and available for use in Reports.

Report Generation

Reports are generated using pre-prepared layouts which are copied and populated with actual test data. Report layouts are created using standard EXCEL workbook features and may include multiple worksheets, formatting and macros etc. The generated report comprises an EXCEL workbook.

Client–Server Architecture

A client-server architecture combines centralised data management with distributed test & analysis activities. This facilitates the distribution of user roles and sharing of data/activities within an organisation.

Multiple Test Cell Operation

Testing activities may be distributed across multiple test cells at the test Process level. Each test cell within the scope of TLS has a local TLS Cell Manager client which communicates with the TLS Repository server and the test cell Automation System.

Project Model

Related test activities and data are grouped within a Project model. A single Project may cover one or more Units Under Test (UUT) and provide multi-phase Tests on each one.

Dataset Cards

Dataset Cards are used to store information which is regularly used and/or common to many Projects. Examples include Fuel, Engine, Vehicle and Manufacturer data. This prevents unnecessary duplication and simplifies operator tasks.

Pick lists

Pick Lists are used simplify data entry and dataset Card Selection. This provides an efficient way of locating and selecting standard datasets into Projects and gives user friendly names to otherwise cryptic data values.

Configurable Data Repository

The TLS Repository is configurable using the TLS Lab Manager client to suite organisational requirements. This includes dataset Card and Project definition Templates, Pick Lists, Data IDs and test Process sequences.

Easy to use GUI

The TLS client GUI makes extensive use of tabbed screens, lists and step-by-step 'Wizards' for performing operator tasks. Automatically created PDF versions of reports are viewable directly within the TLS GUI.

Automation System Data Input and Extraction

TLS can be configured to set and read specific data values on the test cell Automation System at individual test Procedure level. This allows input parameterisation of Automation System test sequences and extraction of pertinent result data upon completion.

Automation System Log File Archiving

Log files from the test cell Automation System are automatically copied and archived to the TLS Repository by the local TLS Cell Manager client. Selective log file copying, renaming and archive hierarchal folder structure is configured using macros which may reference test data values.

Automation System calibration state and operator name recording

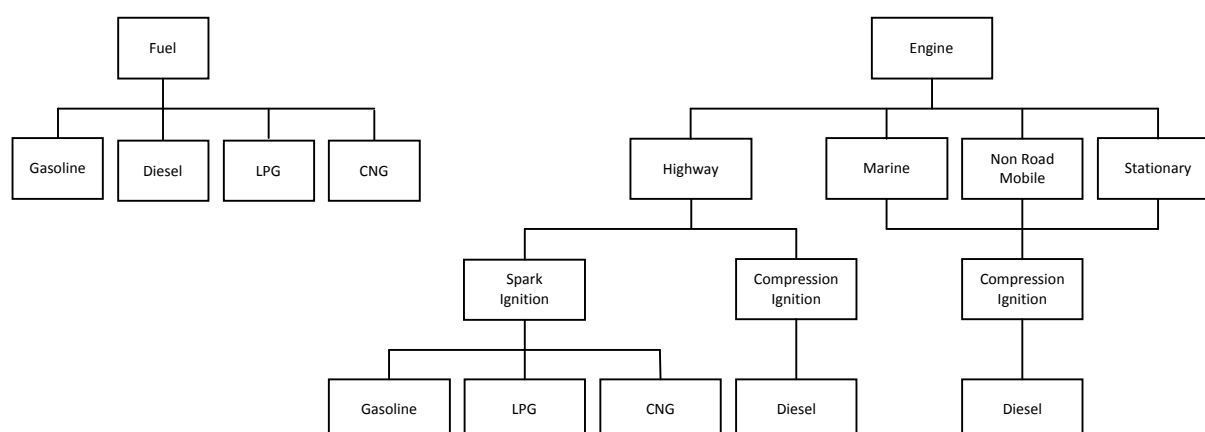
The current overall calibration state & operator name reported by the test cell Automation System is captured and stored at the test Procedure level within TLS. This information can be subsequently be used in reports generated by TLS.

TEMPLATE BASED DATASET CONFIGURATIONS

TLS uses configurable Templates to create dataset Cards which meet specific organisational requirements. Templates and dataset Cards are stored in the TLS Repository server and are accessible to all connected clients.

The TLS Lab Manager client is used to configure Templates and create/edit dataset Cards. Each root Template comprises a set of definable Data Fields and may incorporate a multi-layer hierarchy of Sub-Templates such that the resulting dataset Cards contain Data Fields with relevant context.

For a given Template type (e.g. Fuel) this allows data fields common to all types to be contained within the root Template and additional type specific data fields contained within Sub-Templates. This approach allows type specific data entry at the time of dataset Card creation and during subsequent editing and avoids inclusion of data which is not appropriate for a specific type.



For example: Fuel template may be configured create datasets for Gasoline, Diesel and LPG which have data fields specific to the fuel type. The root template is Fuel; sub-templates used to refine for Gasoline, Diesel, LPG and CNG.

Engine template may be configured to create datasets for Highway, Marine, Non-Road and Stationary use, refined for Spark and Compression ignition types, and further refined to include fuel and after treatment type. The root template is Engine; sub-templates are used to refine as required.

Each Data Field within a Template may be customised. The main customisable parameters are given below and many others are available:

Key Field	Four data fields within each dataset may be designated as key fields for selection and grouping purposes.
Name	Used for display purposes and report generation.
Description	Used for display purposes.
Units	Unit of the value.
Input mode	Method of data entry, for example: edit box, date picker, Pick List, system (e.g. current time of day) etc.
Life Cycle	Defines when the user will be prompted for data input, for example: at creation, when scheduling a Process, when running a Process, when creating a Report, etc.

Life Cycle mode	Defines whether the data is optional, mandatory (i.e. must be present to continue), or read only (visible but not editable) at each point of the life cycle.
Data type	Type of data, for example: integer, decimal, boolean, text, date etc.
Precision	Number of decimal places in decimal values

REGULATION EMISSIONS CALCULATIONS

TLS optionally provides a module for performing emissions calculations for test cycles which are conducted in accordance with regulatory test protocols.

Process Log File

All raw data and configuration required to perform regulatory emissions calculations and the calculated results for a test Process is stored in a single Process Log file.

Multiple modal sample points (e.g. raw, dilute, tracer, HFID) with time alignment and bag data are supported. The Process Log file uses a text format with single line records and may be viewed in any application capable of opening large text files.

TLS automatically updates the data, performs the required calculations and stores this file on the Repository server at the end of each test Process run. Results data is automatically extracted from the Process Log file and available for immediate online viewing and reporting.

Supported test cycles - Please contact Sierra CP for the most recent list.

EPA CFR 40 part 1033 Ramped Modal to EPA CFR 40 part 1065	<i>Locomotive engines</i>
EPA CFR 40 part 1039 Discrete Mode, Ramped Mode and Transient to EPA CFR 40 part 1065	<i>Non-road compression ignition engines</i>
EPA CFR 40 part 1042 Discrete Mode and Ramped Mode to EPA CFR 40 part 1065	<i>Marine compression ignition engines</i>
EPA CFR 40 part 1048 Discrete Mode, Ramped Mode and Transient to EPA CFR 40 part 1065	<i>Large non-road spark ignition engines</i>
EPA CFR 40 part 1054 Discrete Mode and Ramped Mode to EPA CFR 40 part 1065	<i>Small non-road spark ignition engines</i>
EPA CFR 40 part 86 Subpart B FTP 72, FTP75, NYCC, HWFET, SC03, US06	<i>Light duty on-road vehicles and trucks</i>
EPA CFR 40 part 86 Subpart D Discrete Mode	<i>Gasoline and Heavy duty Diesel engines</i>
EPA CFR 40 part 86 Subpart F	<i>Motor cycles</i>
EPA CFR 40 part 86 Subpart I Smoke	<i>Gasoline and Heavy duty Diesel engines</i>
EPA CFR 40 part 86 Subpart N Discrete Mode, Ramped Mode and Transient	<i>On-road Otto cycle and heavy duty Diesel engines</i>
EPA CFR 40 part 90 Discrete Mode	<i>Small non-road spark ignition engines</i>
EEC 70/220/EC Type I and VI MVEG-A 90, MVEG-A 120, MVEG B 90, MVEG B 120, Type II Idle CO	<i>Road vehicles</i>
EEC 97/68/EC Discrete Mode and Transient	<i>Non-road mobile engines</i>
EEC 86/77/EEC Discrete Mode, ELR and Transient	<i>On-road engines</i>
R83 Type I and VI MVEG-A 90, MVEG-A 120, MVEG B 90, MVEG B 120	<i>Road vehicles</i>
ISO 8178 Discrete Mode	<i>Engines</i>
JAPAN NLT 2005 10/15 mode, 10 mode, 11 mode, JC08	<i>Road vehicles</i>
Thailand TIS 2155-2546 I and VI MVEG-A 90, MVEG-A 120, MVEG B 90, MVEG B 120, Bangkok	<i>Road vehicles</i>

REPORT GENERATION

Reports are produced in EXCEL workbook format and a PDF copy is automatically created for online viewing within the TLS Lab Manger and Cell Manager clients. TLS generates reports by copying a pre-prepared layout and populating it with data. The finished report is then stored on the TLS Repository in a folder hierarchy specified using macros.

Layout Templates

Report layouts are created using the EXCEL. Multiple worksheets, embedded macros and formatting options may be used. TLS uses NAMES to tag data. The layout design references NAMEed data within individual cells to create the desired format. Automation System data logs may also be automatically exported into reports using a row (log) and column (channel) format. Layout templates are stored in a folder hierarchy specified using macros. This allows multiple report templates and a Pick List system to present a sub-list of all available reports based on the test Process that was run.

TEST PROCESSES AND PROCEDURES

A test Process defines a set of test Procedures that will be run sequentially on a test cell Automation System. Each test Procedure within a Process is a predefined operation that is performed by the test cell Automation System, for example a power curve. TLS allows Automation System test Procedures to be parameterised and automatically extracts results data on completion. For example the speed interval of a power curve may be specified in the Process configuration.

Automation System test Procedures are ‘atomic’. This means that the only interaction between TLS and the Automation System occurs at the start and end of each Procedure. A Project test Process is scheduled on a specific test cell using TLS Lab Manager. The scheduled test Process automatically appears on the local test cell TLS Cell Manager client. The test cell operator uses the Cell Manager module to select a scheduled test Process and run it. During a test Procedure the Automation System may require the operator to make a decision to Abort, Continue or Retry an operation. Test Processes and Procedures may be added, deleted and modified using TLS Lab Manager editors. The configuration of the dataset Cards allows data to be requested at appropriate times. For example a UUT serial number may be requested when scheduling a test Process and a fuel batch number when running it.

Typical test Process Procedure sequences that may be configured are:

8-mode steady state

Initialise
Emissions Bench Pre Check
Engine Start
Engine Warm up
8-mode test cycle
Emissions Bench Post Check

Transient

Initialise
Emissions Bench Pre Check
Engine Start
Transient Cycle (cold)
Soak
Transient Cycle (hot)
Emissions Bench Post Check

Performance

Initialise
Engine Start
Engine Warm up
Power Map
Power Curve
Engine Cool down

Oil Carry Over

Initialise
Engine Start
CCV Cycle

Manual Development Test

Initialise
Engine Start
Manual Operation

Vehicle

Initialise
Emissions Bench Pre Check
Vehicle centering
Vehicle trim
Vehicle coastdown check
Test cycle
Emissions Bench Post Check

Innovate to Differentiate.



In Cell Equipment

Ancillary Equipment to Support
New and Existing Test Cells

IN CELL EQUIPMENT

Our philosophy of flexibility and simplicity of design helps provide the foundation for our range of modular, ancillary in-cell products to meet the diverse and demanding requirement of modern test facilities. Our in-cell support solutions are designed as part of our turn-key engine and vehicle test cell automation and are also available as stand-alone solutions suitable for use with non CP host test systems.

Sierra CP offer a wide range of dynamometers to meet most testing requirements. All Sierra CPs dynamometers are custom selected and designed to match a customer requirement, as we understand that a 'one size fit all' solution is not ideal for most customers.

Sierra CPs range of ancillary products are designed to accompany and integrate with any existing or new build engine or vehicle test cell installations. CP are able to offer products to provide air inlet and exhaust back pressure valves, engine fluid conditioning solutions, fuel measurement and conditioning solutions as well as mechanical throttle actuation systems.



Innovate to Differentiate.



Dynamometers

AC, Eddy Current or Hydraulic Dynamometers

Issue 4.1

INTRODUCTION

Sierra CP offers a large range of various dynamometers which are suitable for a wide range of petrol and diesel engines and other rotating test requirements. Sierra CP can supply motoring and absorbing AC Dynamometers and inverter drives up to 1,000 kW and 8,000 Nm. Eddy Current Dynamometers with a performance ranging from 5 to 3,000 kW and torques up to 20,000 Nm can be offered. Hydraulic machines are also available to meet most requirements with powers in excess of 20MW available. Sierra CP select and design dynamometers based on customer requirements. For further details and quotation please contact Sierra CP with maximum engine power, torque and speed requirements. Alternatively provide Sierra CP with engine performance curves.

BENEFITS AND FEATURES

- Low Inertia
- High Performance to Cost Ratio
- Bespoke design to meet specific customer requirements

APPLICATIONS

- Emissions Certification Work
- Transient Test Cycles
- Drive Cycles
- Vehicle Simulation Work
- Endurance and Reliability

When operating with Sierra CP Engineering's CADET V14 test systems all machines are suitable to generate the dynamic test requirements for Federal and European emissions tests.

AC DYNAMOMETERS

Sierra CP are able to offer a vast selection of AC dynamometers ranging from 15kW to over 1,000kW with bespoke dynamometer designing capabilities to cater for all testing requirements.

Standard AC dynamometer construction includes dynamometer base frames of desired centre height, capable of various mounting arrangements.

Torque measurement is most commonly from an in line torque flange for high accuracy and speed measurement from an optical encoder. Calibration arms and weights pan are included as standard. Calibration weights can be provided by Sierra CP on request. Above is shown a Sierra CP 840kW AC dynamometer complete with rotor lock, torque flange with calibration arms and pans.

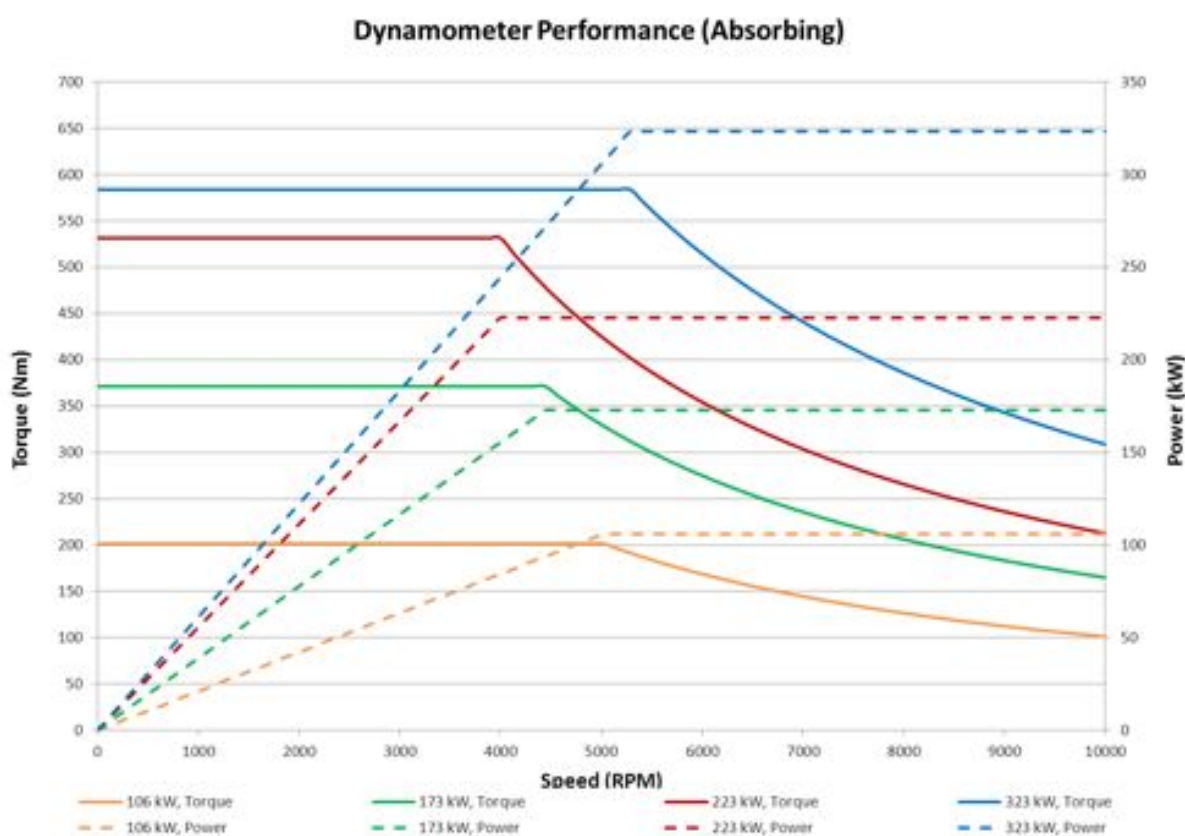


Each dynamometer is matched to a 3-phase AC four quadrant regenerative drive. The drive incorporates filters for high and low order harmonics to prevent cross talk with adjacent equipment. The range of drives is physically compact without sacrificing outright performance.

The standard range of dynamometers described in this Data Sheet has been carefully selected to show a range of dynamometers suitable majority needs of the engine testing industry, however Sierra CP would be pleased to consider any requirements for special applications. This includes performance enhancements and operational requirements such as water cooled motors, double ended shafts, provision of shaft guarding and drive shafts, palletised dynamometer systems and any other specialist requirements which you might have.

Sierra CP treats each specification individually and offers bespoke dynamometer solutions to best suit the customer's requirement.

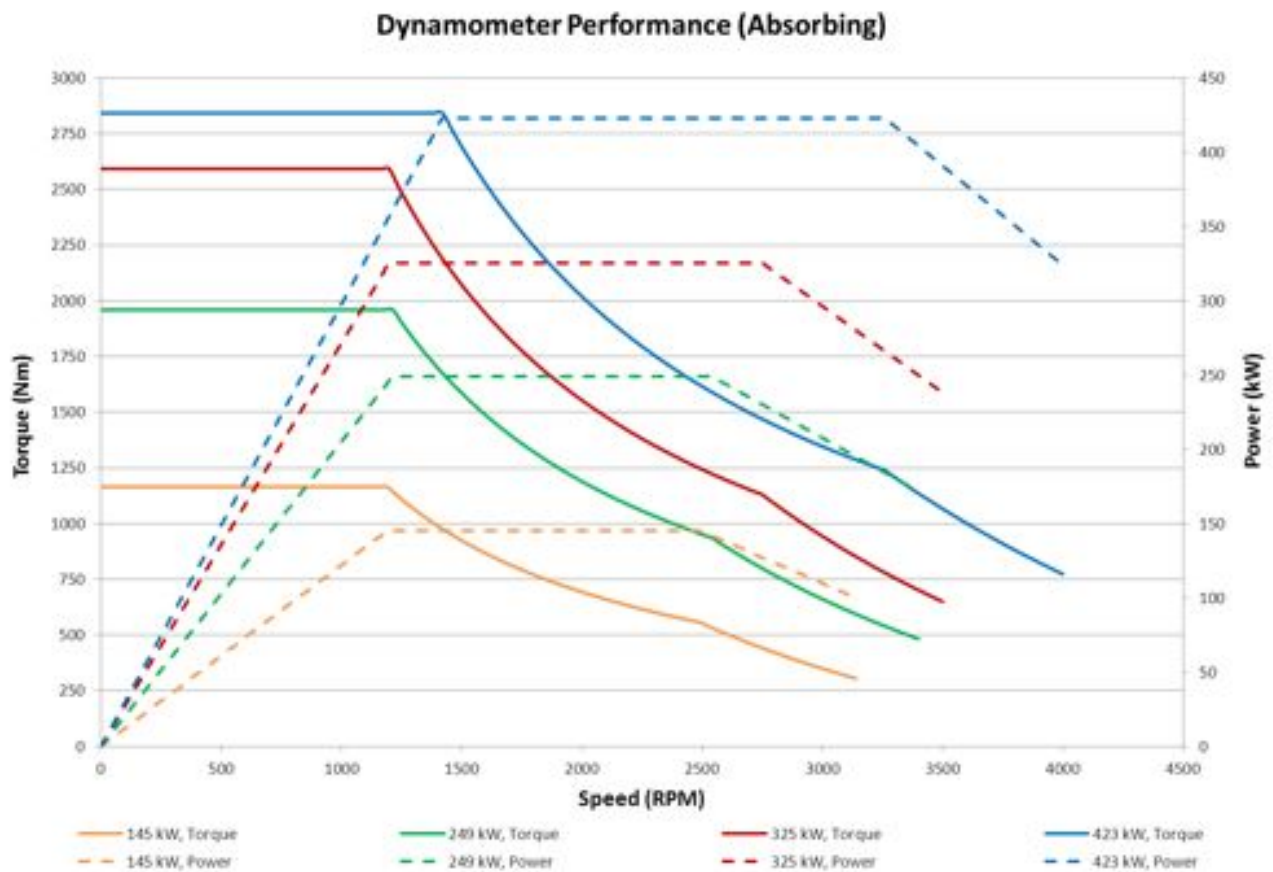
High Speed Dynamometers



	106kW		173kW		223kW		323kW	
	Base	Max	Base	Max	Base	Max	Base	Max
Speed rpm	5,000	10,000	4,500	10,000	4,000	10,000	5,300	10,000
Absorbing Torque Nm	200	100	370	160	530	210	580	310
Absorbing Power kW	106		173		223		323	
Free Acc'l'n rpm/sec	15,917 up to Base		14,976 up to Base		16,465 up to Base		18,112 up to Base	
Rotor Inertia kg/m ²	0.12		0.22		0.29		0.29	
Current amps	190		290		380		570	

Speeds of 15,000+ RPM are achievable with specialist bearings and cooling

High Torque Dynamometers



	145kW		249kW		325kW		423kW	
	Base	Max	Base	Max	Base	Max	Base	Max
Speed rpm	1,200	3,150	1,200	3,400	1,200	3,500	1,400	4,000
Absorbing Torque Nm	1,170	305	1,960	480	2,600	650	2,850	770
Absorbing Power kW	145		249		325		423	
Free Accl'n rpm/sec	10,541 up to Base		10,173 up to Base		9,441 up to Base		9,652 up to Base	
Rotor Inertia kg/m ²	1.06		1.84		2.63		2.82	
Current amps	255		430		585		735	

Please contact Sierra CP with your requirements to receive a dynamometer sized specifically for your requirements.

EDDY CURRENT DYNAMOMETERS

A selection of eddy current dynamometers that Sierra CP can supply are listed below:

Power (kW)	Max. Torque (Nm) at (rpm)	Max Speed (rpm)	Inertia (kg.m ²)
5	17 at 2,800	15,000	0.002
20	120 at 1,600	15,000	0.02
40	150 at 2,500	15,000	0.02
75	450 at 1,800	13,000	0.05
110	450 at 2,300	13,000	0.05
190	800 at 2,300	12,000	0.15
290	2,000 at 1,400	9,000	0.6
400	1,600 at 2,200	9,000	0.3
440	800 at 4,500	12,000	0.29
500	3,500 at 1,400	5,500	3.0
580	4,000 at 1,400	9,000	0.9
580	1,800 at 3,000	7,000	1.1
660	1,200 at 5,500	15,000	1.5
870	2,000 at 4,200	9,000	1.5
870	6,000 at 1,400	6,500	1.7
1,000	7,000 at 1,400	3,500	5.5
1,500	10,500 at 1,400	3,500	8.1
2,500	15,000 at 1,600	3,500	23.0
3,200	20,000 at 1,900	2,500	33.6

Various eddy current dynamometers not listed are also available as well as reconditioned units, please contact Sierra CP for further details.

Typically eddy current dynamometers are supplied with the following:

- Toothed wheel speed pickup
- Swing frame construction with load cell
- Calibration arms and weight pans
- Inlet filters
- OM12 power module



HYDRAULIC DYNAMOMETERS

Sierra CP are able to supply a range a hydraulic dynamometers suitable for most testing applications up to 20MW. For further details please contact Sierra CP with your specific requirements. Re-conditioned dynamometers are also available.

Typically hydraulic dynamometers are supplied with the following:

- Toothed wheel speed pickup
- Swing frame construction with load cell
- Calibration arms and weight pans
- Inlet filters
- Inlet/Outlet control valve with power module

OPTIONS

A number of options are available with most dynamometers. A selection of these are:

- Drive cabinets for motoring or absorbing from AC dynamometers (new or existing dynamometers)
- Dynamometer control systems (see CADET V14 and CADET Edge datasheets)
- Shaft guards
- Dynamometer mounting frames
- Load cells
- In-line torque meters
- Encoders and toothed wheels
- Climatic and NVH solutions
- Chassis dynamometer systems (see separate datasheet)
- Polo magnetic water filters

Sierra CP provide suitable AC variable frequency 4 quadrant regenerative drives sized to the AC dynamometer requirements, including any overload requirements.

For a full range of AC dynamometers and drives please contact Sierra CP Engineering with any specific requirements. Sierra CP will provide a range of dynamometer and drive solutions for your specific testing applications.

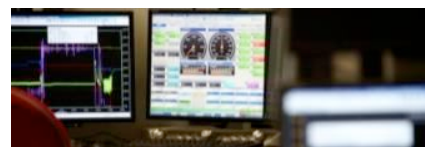
CUSTOMER RESPONSIBILITIES

The customer should make available or prepare the following services as necessary:

- 3 phase power and power isolation as required (G59 relay in UK)
- Cooling/bed water supplies (Sierra CP can provide if necessary)
- Control System with Safety Monitoring (CADET options offered or 3rd Party system)

These will be confirmed and discussed during the project phase.

Innovate to Differentiate.



Valve Manifold and Cooling Post Engine Circuit Temperature Control

Issue 4.1

INTRODUCTION

The Sierra CP valve manifold assembly is designed to provide temperature control of engine coolant, engine oil and turbo /intercooler (or other cooling circuits) in engine test applications, from a single bed water feed and return. The compact module supports the rapid control of coolant flow through the three independent bed water circuits. These circuits are usually connected to suitably sized heat exchangers, which in turn are connected to the engine circuits. Sierra CP can offer a cooling post which is a single unit that integrates the valve manifold and appropriately sized heat exchangers.

The flow rate to the heat exchanger for each valve manifold circuit is controlled by adjusting a 3 way electro-pneumatically actuated ball valve. The flow range/back pressure of each circuit is manually pre-set by adjusting integral ball valves within the valve manifold, which allows the manifold to be used with a wide range of engine sizes.



Closed loop temperature control is achieved by integrating PRT sensors into the engine circuit supply pipework. The 3 way valves are then actuated such that the bed water flow through the heat exchangers is sufficient to remove the required amount of heat and thus provide the necessary engine circuit supply temperatures. The valve manifold can be controlled by a CADET system, CADET Fuel Controller (see separate datasheet) or 3rd party control system (customer will need to provide the required control channels and necessary software).



SPECIFICATION

Cooling Module Requirement	Specification
Feed and Return Connections	2" BSP Female x 34mm*
Valve Manifold Cooling Circuit Connections	Large: 1 ½" BSP Female* Small: ¾" BSP Female*
Coolant Supply Pressure	2 - 6 Bar
Electrical Connections Per Circuit**	
Valve Actuation	4-20mA Control Signal (8V Minimum)
PRT Feedback	3 Wire PRT Input

*Hose end push fits are also available as an option

**Connections are provided on the CADET & CADET Compact Engine Electrics Panel

BENEFITS AND FEATURES

- Only two connections required for feed and return water
- Compact unit reduces clutter in the cell
- Proportioning valves aid accurate flow control
- Adjustable for a wide range of engine sizes
- Can be expanded to offer additional cooling channels (such as dynamometer cooling)
- Cooling post can be mounted on castors to be moved around the cell as required

APPLICATIONS

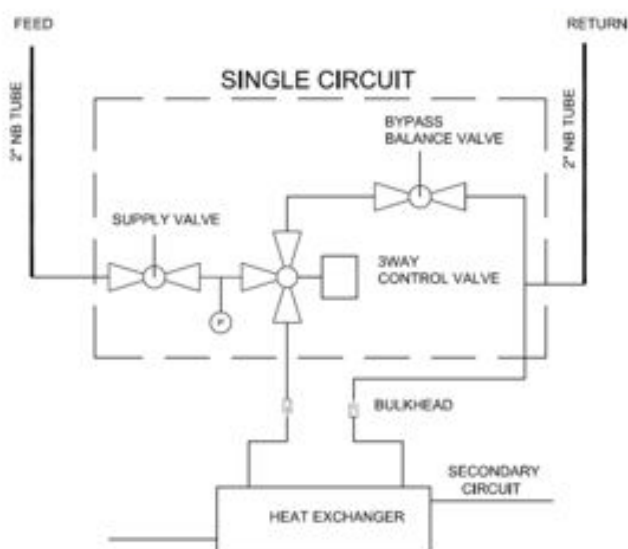
- Engine test work, where air cooling of radiator is not appropriate
- Emissions work to control engine fluids to within allowable limits
- Connect to existing Heat Exchangers for automated PID control

SYSTEM DESCRIPTION

The module, which supports both hose and screw fittings, requires one feed and one return connection. This allows for maintenance, especially when connections are via silicon rubber hose. In typical installations the return flow from the three cooling circuits will be via the free end of the manifold return allowing a single point of coupling for the test bed coolant feed and return.

The manifold will operate with a large range of coolant pressure, as the required maximum flow rate is pre-set using the manual range adjustment valves. This feature ensures that each circuit may be optimised for the required heat dissipation and thus coolant circuits may be pre-set for the engine size and power output in use. This ensures that the control valve operates over its full range of travel

The ability to match the internal return flows with the heat-exchanger circuit by using the integral balance valves ensures that the control valves operate in a linear manner and are therefore well



matched to the range of flow control required. The three way control valves respond to 4-20mA position set-points and provide fast and precise positional control, resulting in responsive and precise temperature control. The module is suitable for vertical or horizontal mounting.

The cooling water circuits on the cooling post are piped to individual Heat Exchangers mounted on the post. The supply lines from the engine can be either via quick-fit connectors or traditional threaded couplings. The capacities of the various heat exchangers are sized on the customers application.

OPTIONS

As standard the valve manifold is supplied with 1 off 1 ½" circuit for coolant conditioning and 2 off ¾" circuits for oil and intercooling. On request Sierra CP can provide 2 off or 3 off 1 ½" circuits instead, or provide valve manifolds with 4+ circuits. Please contact Sierra CP with your specific requirements.

The Sierra CP cooling post is usually built with a header tank style heat exchanger for coolant conditioning and a lower mounted oil coolant heat exchanger. These heat exchangers are sized to be sufficient for the customers' largest engine size. The intercooler heat exchanger is not usually supplied however Sierra CP can integrate coolant/air heat exchangers into the cooling post as required.

Sierra CP are able to supply custom conditioning solutions. Examples of these are:

- Systems with integrated heating and pumps, for engine pre conditioning
- Oil pressure control
- All stainless steel units
- Multiple heat exchanges integrated into a single cooling circuit, which can be bypassed depending on the engine size under test
- Heat exchangers built onto engine frames
- Palletised cooling solutions
- Systems with integrated flow measurement



Please contact Sierra CP with your specific requirements for further information.

CUSTOMER RESPONSIBILITIES

The customer should be responsible for providing the following services:

- Compressed air supply – Instrument grade, dry, dust and oil free
- Bed or cooling water feed and return
- Pumps, filters and additional valves if required

These will be confirmed and discussed during the project phase.

Innovate to Differentiate.



Mechanical Throttle Actuator

AT12 and OM22

Issue 4.1

INTRODUCTION

The AT12 is an enclosed DC motor driven fast acting Mechanical Throttle Actuator which can be used with Sierra CPs or 3rd party control systems. The actuator provides performance suitable for 'pull cable type' throttle applications ranging from small two stroke engines up to heavy duty diesels and racing engines. A lever/rod actuation version of the AT12 is also available for pedal or alternative actuation requirements. The OM22 power module accompanies the AT12 and allows closed loop positional control of the actuator, with the test cell controller providing a 4-20mA positional control signal.



SPECIFICATION



The AT 12 is built around a permanent magnet DC motor with a worm reduction gearbox and servo potentiometer. The specification of the AT12 and OM22 Control module can be found below:

Actuator Specification	Units	Value
AT12 Specification		
Maximum Pull Force	N	130
Maximum Cable Travel	mm	92 (210 degrees)
Response Time	ms	120
0-180 Degrees Time	ms	250
Operating Temperature	°C	0-40
AT12 Dimensions (H x W x D)	mm	120 x 220 x 120
Protection Rating	-	IP55 with Splash Proof Connectors
OM22 Electrical Requirements (CADET Provides These Control Signals as Standard)		
Positional Control Signal	mA	0-20
Feedback Signal (Not Required for Control)	mA	4-20
Shutdown Signal (If removed, AT12 returns to 0%, assuming the AC supply is active)	V DC	24 (at 40mA)
Power Requirement	V AC	110/230 ±10% (Specify on Order)

BENEFITS AND FEATURES

- Fast Acting
- Compact Unit
- Operates in any Plane
- Easily Adaptable to Various Throttle Systems
- Safety shutdown system (24VDC active signal)
- Closed loop positional control with setpoints provided by CADET or 3rd party control system

OPTIONS

As standard the throttle actuation system will be supplied with the following:

- AT12 mechanical throttle actuator
- OM22 power module, built into a wall mountable enclosure (can also be supplied loose)
- 1.5 metre Bowden cable with clevis pins to connect to the customers throttle system
- 1.5 metre loom between AT12 and OM22 enclosure
- 5 metre loom from OM22 enclosure to 110/230V supply
- 10 metre control loom from OM22 to the control system (please specify CADET or Other control system on order placement)



AT12 Actuator – BLCAA12



OM22 Power Module in Enclosure – BLEXV12



BLEXV12C - LOOM OM22 ENC TO DB-VC-01

Loom to CADET (9 Way D Type - BLEXV12C) or other control system (Free ends - BLEXV12D)

As options Sierra CP can provide the following:

- Alternative throttle cable and loom lengths
- AT12 in a pedal actuator or motorcycle throttle actuator
- Up-rated performance (faster response, higher force or larger travel)
- Ignition actuation adaptation (Key or Push Button Start bolt on module)
- OM22 with alternative connectors

Innovate to Differentiate.

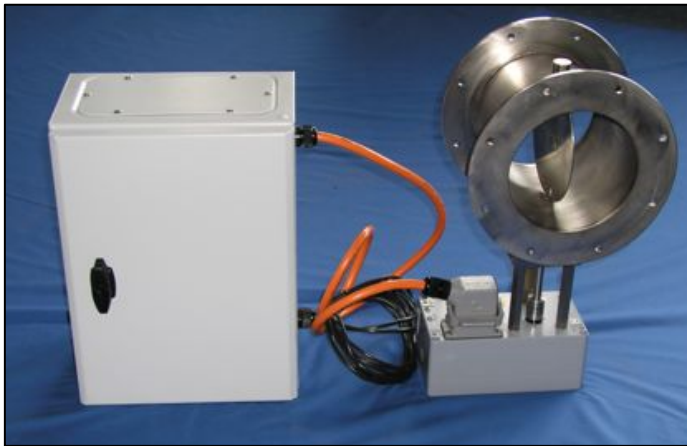


Exhaust Back Pressure and Air Valves

Exhaust and Inlet Air Pressure Simulation

Issue 4.2

INTRODUCTION



The Exhaust Back Pressure Valves and Air Valves are fast acting ALL Stainless Steel Butterfly Valves ranging from 2" – 8" diameter, controlled by an AV12 electronic actuator. The valves are used for adjusting and simulating the effective pressure drop of the test bed inlet and exhaust system. The valves are supplied with OM22 Closed loop control modules, which adjust the position of the valve in response to a 0-20mA control signal. Closed loop pressure control can be achieved by installing a

pressure transducer into the intake/exhaust ductwork. The signal from the pressure transducer (not supplied) can then be read by one of CADET V14's fast analogue channels, or by a third party control system, to provide closed loop pressure control.

BENEFITS AND FEATURES

- Fast Acting
- Compact Unit
- Operates in any Plane
- Easily Adaptable to a variety of Exhaust Systems
- Different Diameters Available

APPLICATIONS

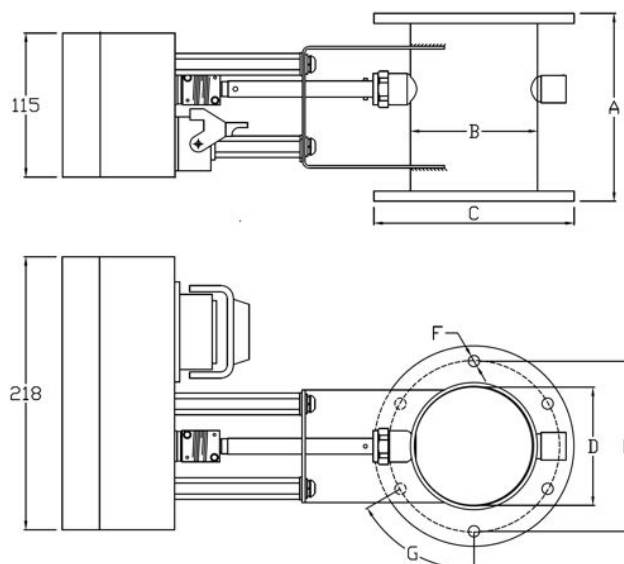
- Simulation of pressure drops
 - Exhaust back pressure
 - Turbo pressure simulation
 - Filter simulation
 - Ambient pressure reduction
- Transient control
- Compliments CAHU for exhaust pressure control
- Emissions Work
- Research and Development work



SPECIFICATION

The specification for the various sizes of valves and electrical requirements are detailed below. Please note the following:

- Diameter D is the inner diameter of the flange
- Flange thickness is 8mm for 3" - 8" valves
- The 2" valve uses a V-clamp coupling system, instead of a bolted flange and is cable driven to minimise weight and size
- Exhaust and Air Valves have nominally the same design, with the exception of the distance between valve and actuator, which is larger for exhaust valves



Valve Sizes		2"	4"	5"	6"	8"
Maximum Recommended Airflow	m ³ /hr	500	1,500	2,500	3,500	6,500
Dimension A	mm	70	150	200	200	240
Diameter B (Nominal)	mm	60	102	135	168	224
Diameter C	mm	75	160	210	260	290
Diameter D	mm	50	96	127	161	215
Diameter E (PCD)	mm	-	136	175	230	265
Diameter F	mm	-	9	11	9	10
Angle G	°	-	60	60	45	45
Weight: (with Actuator)	kg	4.2	6.7	8.8	11	12
Max Air Temperature	°C	800 (Exhaust Valves) 100 (Air Valves)				
Response Time	ms	120				
Valve Speed (0-90 degrees)	ms	150				

Electrical requirements for the OM22 closed loop positional control module (CADET systems already provide these signals as standard).

Signal Type	Unit	Value
Positional Control Signal	mA	0-20
Positional Feedback Signal (Not Required for Control)	mA	4-20
Shutdown Signal (If removed valve returns to fully open, assuming the AC supply is active)	V DC	24 (at 40mA)
Power Requirement	V AC	110/230 ±10% (Specify on Order)

SYSTEM DESCRIPTION



The valves are actuated by the AV12 actuator, which consists of a permanent magnet DC motor, which is driven through a worm reduction gearbox. Actuator position feedback is provided by an internally mounted servo potentiometer within the AV12, which is directly coupled to the output shaft.

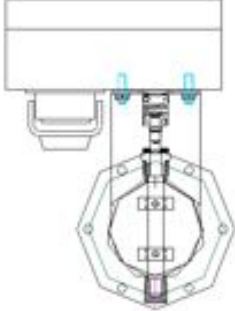
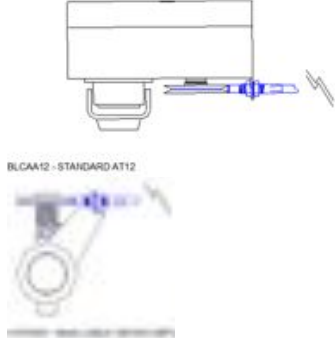
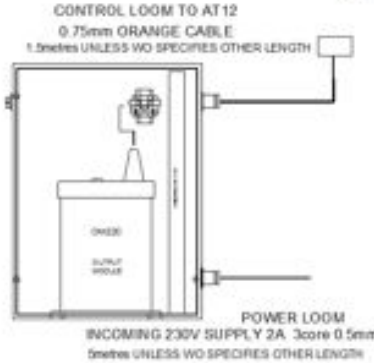
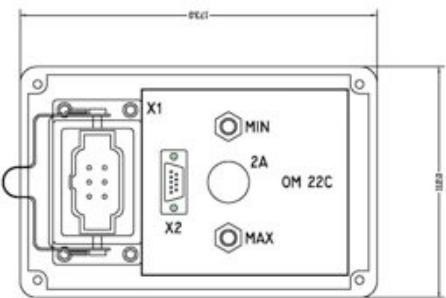
The unit is very easy to install in existing ductwork due to its compact size. A single electrical loom between the actuator and the OM22 control module is required which connects via a splash-proof connector. The actuator can be mounted in any plane, however Sierra CP recommend the actuator is mounted to the side, to reduce heating effects from the exhaust system. The valve is constructed entirely from TIG Welded stainless steel and the actuator is rated to IP55 to provide sufficient protection for most environments in test cells.

The 2" valve can be supplied with a high pressure insert. This further reduces the bore of the valve, to offer precision control for low flowing applications, such as single cylinder engine testing.



OPTIONS

There are a number of different valve arrangements available to the customer; these are detailed in the table below. One variant should be selected from each row:

Valve and Actuator	 A14 – 4" Exhaust Valve A15 – 5" Exhaust Valve A16 – 6" Exhaust Valve A18 – 8" Exhaust Valve	 A24 – 4" Air Valve A25 – 5" Air Valve A26 – 6" Air Valve A28 – 8" Air Valve	 A12 -2" Cable Driven Valve with AT12 Actuator and 1.5m Cable A30 – High Pressure Insert (2" valve order code also required)
Control Module	 B1 - OM22 Control Module in Enclosure with Power (5m) and AT12 Control (1.5m) Looms	 B2 - OM22 Control Module, with Power (5m) and AT12 Control (1.5m) Looms	
Control System Loom	 C1 –Loom to CADET (9 Way D-Type Connector) 10 Metres C2 –Loom to 3rd Party Control System (Free Ends) 10 Metres		
Mating Flanges	D0 – No Mating Flanges D2 – 2" Mating Flanges and Clamps D4 – 4" Mating Flanges D5 – 5" Mating Flanges D6 – 6" Mating Flanges D8 – 8" Mating Flanges		

Custom loom lengths are available, please specify on order if required. Sierra CP can also offer valves with custom flanges or custom diameters. Please contact Sierra CP with your requirements for further information. Individual items may also be ordered, simply quote the product selection code required.

Innovate to Differentiate.



AirTrak

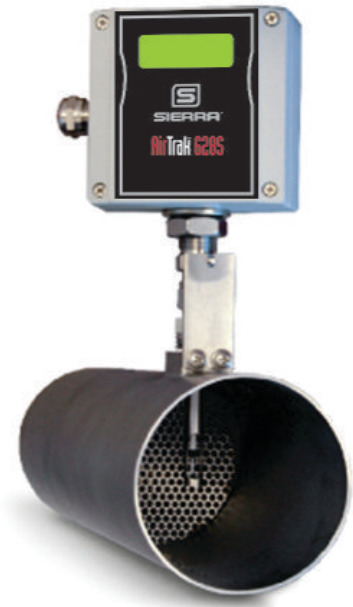
Intake and Combustion Air Measurement

Issue 4.1

INTRODUCTION

Sierra CP's AirTrak 628S Thermal Mass Flow Meter was originally designed to work specifically with our BG3 Particulate Partial Flow Sampling System as an extremely fast, accurate, and repeatable engine air intake mass flow meter. The instrument has proven to be an excellent solution in all engine testing applications.

The meter has an extremely fast 200 millisecond response-time sensor making it ideal for the toughest transient test cycles where flow excursion can approach 10:1 within less than two seconds. Dual-Plate laminar flow profile conditioning elements inside the flow body maintain top performance in heavily constrained piping environments common in engine test cells, where long-straight pipe runs simply do not exist. In addition, the versatile microprocessor-based instrument integrates the functions of easy flow-range adjustment, meter validation and diagnostics in the field, sensor alignment gauge for perfect installation, and a rugged probe-mounted NEMA 4X (IP65) housing.



BENEFITS AND FEATURES

- Accuracy of Point Velocity: +/- 1% of reading above 10% full scale
- Repeatability:
 - +/- 0.5% of full scale below 10% full scale
 - +/- 2% of reading above 10% full scale
- Temperature Coefficient:
 - +/- 0.02% of reading per °F within ± 50°F of customer specified conditions
 - +/- 0.03% of reading per °F within ± 50°F to 100°F of customer specified conditions
 - +/- 0.04% of reading per °C within ± 25°C of customer specified conditions
 - +/- 0.06% of reading per °C within ± 25°C to 50°C of customer specified conditions
- Pressure Coefficient: 0.02% per psi for air
- Response Time: 200 milliseconds to 63% of final velocity value
- 15:1 turndown gives high accuracy at low idle conditions
- Low pressure drop
- Dual-plate laminar flow conditioning element for constrained piping environments
- Smart electronics permit field adjustment of critical flow meter settings
- Field validation of flow meter calibration
- 2 x 12 backlit LCD display
- CE approved
- Interfaces & Calibrates via BG-3

APPLICATIONS

- Engine and Vehicle Test Cells
- Plug and play operation with Sierra's Model BG®-3 particulate sampling system

SYSTEM DESCRIPTION

- Gases: Air
- Gas Pressure: 120 psig (8 barg) maximum design pressure
- Gas Temperature: 14° to 176°F (-10° to 80°C)
- Ambient Temperature: 32° to 120°F (0° to 50°C)
- Power Requirements: 18 to 30 VDC (regulated), 625 mA maximum
- Output Signal
 - Linear 0–5 VDC, 1000 ohms minimum load resistance or
 - Linear 4–20 mA proportional to mass flow rate, 700 ohms maximum resistance power supply dependent User-selectable. Active non-galvanically separated or passive galvanically separated (loop power required)
- Alarms: Hard contact user-adjustable high and low Dead band adjustable with Smart Interface™ software Relay ratings. Maximum 42 VAC or 42 VDC, 140 mA
- Displays:
 - Alphanumeric 2 x 12 digit backlit LCD
 - Adjustable variables via on-board switches (password protected) or with Smart Interface™ software
 - Adjustable variables. Full scale (50 to 100 %)
 - Time Response (1 to 7 seconds)
 - Correction factor setting (0.5 to 5)
 - Zero and span
- Totalizer
 - Eight digits (9,999,999) in engineering units
 - Resettable by software, on-board switches or external magnet
- Software
 - Smart Interface™ Windows™-based software Minimum 8 MB of RAM, preferred 16 MB of RAM RS 232 communication
 - Additional features:
 - Alarm dead band adjustment
 - Low flow cut-off adjustment
 - Linearization adjustment
 - Save / Load configurations
 - Flow meter validation
- Wetted Material
 - Probe: 316SS
 - Flow Body: 316SS tubing
 - Sensor: 304SS, glass coating epoxy
- Enclosure: NEMA 4X (IP65) powder-coated cast aluminium
- Electrical Connections: One 1/2-inch female NPT

Innovate to Differentiate.



ExhaustTrak

Direct Exhaust Mass Flow Meter

Issue 4.1

INTRODUCTION

With our roots in flow measurement, Sierra has entered the market with an innovative flow meter, named ExhaustTrak, to handle this tough application. ExhaustTrak is directed toward satisfying customer requirements for a rugged, accurate and fast solution for direct exhaust mass flow measurement, and is specifically designed for transient cycle flow rate measurement.



The unit can measure the mass flow rate of intake air flow, diluted exhaust, raw exhaust (pre or post-aftertreatment), or crank case combustion fumes, since instrumentation pressure line plugging issues no longer exist. Taking clues from our use of porous media (sintered stainless steel) in our patented partial flow dilution tunnel utilized by the BG3, we use circumferential porous media as pressure interface material to elevate subsonic venturi flow meter technology to a whole new level.

The design provides fully averaged radial pressure sampling at the throat and the inlet locations. Flow inaccuracies due to velocity profile skew are minimized. As a result, straight length requirements for installing the ExhaustTrak are relaxed, as it is nearly immune to bias effects created by bend-induced swirl.

WHAT IS IT?

- In-situ direct exhaust mass flow measurement
- Provides accurate, real-time exhaust

mass results.

- No chemical balance analysis needed
- Produces proportional analog signal for PM sampling devices (BG3) or other
- Produces output in engineering units to host
- Fuel H/C input, direct O₂ measurement capability allows for real-time exhaust molecular weight compensation

WHY MEASURE DIRECT EXHAUST MASS FLOW?

Direct, in-situ measurement of exhaust mass flow for raw emissions sampling is difficult to execute. Given the allowance for chemical balance-derived exhaust mass flow for raw emissions sampling in 40CFR Part 1065, direct measurement was initially considered unnecessarily problematic. However a recurring observed bias between raw and dilute gaseous emissions results on transient test cycles has prompted reconsideration of this position.

One drawback to the use of chemical balance methods is that instantaneous exhaust mass flow rate is not available until after the emissions test has been completed. Chemical balance post-test data processing may be complicated due in part to temporal delays in gaseous emissions measurement

system response, created by sample line length and/or individual analyzer response times, relative to an engine operating event such as an acceleration or load acceptance. This approach may be further complicated by required changes in engine exhaust mass flow rate due, for example, to an engine power rating change. Further, modifications of the exhaust system consist which may affect intake or exhaust stack volumes, or a change in after treatment device status, may be particularly problematic. Such changes may create skew, or temporal redistribution, for example, in the relationship between measured combustion air mass flow rates and the actual instantaneous exhaust mass flow rate at the sample zone. Each of the aforementioned elements may contribute to uncertainty in measurement of both exhaust gas mass flow rate and raw engine emission results during engine development and certification.

Due in part to the elements discussed above, it is believed by Sierra-CP that enabling fast and accurate exhaust mass flow rate determination through direct measurement is a necessary step to enable and expand acceptance of raw emissions measurement methods. It is our position that the most robust method for determining real time exhaust mass flow rate is to use direct exhaust mass flow rate measurement with a minimum 10Hz update rate capability. ExhaustTrak is our answer to this challenge.

BENEFITS AND FEATURES

- Sub-Sonic Venturi Technology (Patent Pending)
- Eliminates need for chemical balance mass methods
- Eliminates instantaneous emissions error contributions due to indirect vs. direct exhaust mass flow determination
- Resolves temporal offset vs. intake mass sources through direct measurement at emissions sampling zone
- Plug and play with BG3 provides best possible proportional sampling of particulate matter
- Wide range of flow rate capabilities available
- 1065-recognized exhaust mass measurement technology
- Fully averaged radial pressure sampling
- Porous media as pressure interface
- No plugging issues
- Reduced straight length requirements
- Rugged, accurate & fast measurement

DESCRIPTION

ExhaustTrak is based on exclusive worldwide licensed IP from Caterpillar Inc., patent pending. It is a sub-sonic venturi, engineered for measurement of particle-laden exhaust streams applicable to raw or diluted exhaust, crankcase fumes or combustion air. The mass flow meter benefits from a circular arc throat approach and tapered recovery section and uses short radial porous stainless steel rings for pressure sampling integral to and concentric with the body, at standard venturi pressure measurement locations. The instrument communicates pressure to external averaging rings and pressure transducers. The radial porous rings are machined and processed to provide consistency in diameter versus the parent body material. Other than a slight change in surface finish at the pressure measurement zones, the porous sections are undetectable by sight or feel (no sharp edges). This feature provides radial pressure averaging at the high and low pressure measurement zones and straight length installation requirements relaxed. Due to boundary layer shear, PM build-up on the porous sections is negligible. ExhaustTrak is equipped with a purge

mechanism that can be either manually or automatically activated to address any build-up concerns.

GENERAL SPECIFICATIONS

- Accuracy <1.5% reading
- Pneumatic signal delay due to porous rings is less than 10 milliseconds
- Permanent pressure loss is less than 10% of delta-P
- ExhaustTrak is custom-sized by exhaust pipe diameter and engine back pressure requirements.
- Typical peak back pressure is less than 1kPa
- Fuel H/C is user-definable in the ExhaustTrak software
- ExhaustTrak uses user-inputted fuel H/C and measured exhaust O2 readings to determine exhaust molecular weight (density) and provide >10Hz flow rate output (supports BG3 transient sampling, raw gaseous measurement)

CALIBRATION

- ExhaustTrak pressure, temperature instrumentation is separately calibrated against reference standards
- Venturi body coefficient of discharge, (Cd) vs. Reynolds number (Re#) is determined using traceable flow standards, on air (flowing calibration)
- ExhaustTrak instrumentation and a generic Cd-Re# curve-fit are active
- The calibration-based Cd vs. Re# results are curve-fitted and the calibration-generated coefficients replace the generic curve-fit in the software
- This method resolves small calibration errors from the individual transducer calibration, creating a ExhaustTrak system calibration directly traceable to reference standards

OPERATION

- System is installed at desired measurement location
- User inputs fuel H/C into setup screen
- Establish serial communications with host, BG3 (if applicable)
- System is ready to measure

Communication Setup

Exhaust-Trak Communication Settings

Host -> Exhaust Trak Communication

Connection Method: Ethernet

Exhaust-Trak IP: 192.168.1.51

TCP Port: 23

Com Port: COM1

Serial Baudrate: 115200

Save Com Settings

Current Exhaust Trak Communication Settings

IP Address: 192.168.1.51

Subnet Mask: 255.255.0.0

TCP Port: 23

Serial Baudrate: 115200

Update Exhaust-Trak Settings

Exhaust-Trak Setup

Exhaust-Trak Parameters

Settings | Data Logging | Limits | Advanced Settings

Delta P Drift: 0.027 kPa

Engineer Initials: CRH

Throat Diameter: 3.495 Inches

Pipe Diameter: 4.875 Inches

Venturi Serial: 123-456

Oxygen Sensor Present? ☐

Zero Flow if Delta-P <=0 ☒

Cd vs. Re Coefficients

C1: 9.59585E-1

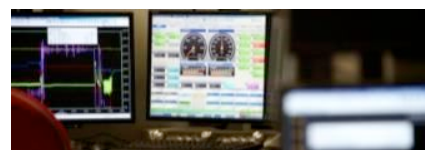
C2: 1.30645E-7

C3: -2.0294E-13

C4: 1.06761E-19

Update Exhaust-Trak Parameters

Innovate to Differentiate.



Fuel Systems

Precision Consumption Measurement and Conditioning

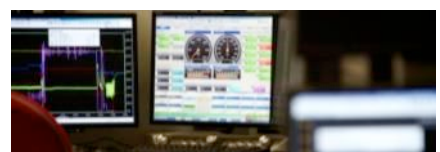
FUEL SYSTEMS

Sierra CP has a complete range of measurement and conditioning solutions for fuel and other liquids and gasses associated with engine and vehicle testing. With over 40 years of experience in fluid flow measurement, Sierra CP brings tremendous expertise and passion to this sector. Sierra CP offer a range of fuel temperature conditioning and settable fuel pressure delivery modules for steady state and transient testing, to compliment the range of gravimetric, transient and coriolis fuel meters available.

These are modular units and can be integrated into no Sierra CP host systems, and introduced to the test cell as requirements dictate. As the demand for fuel systems have increased Sierra CP have developed an independent fuel controller, which will allow any Sierra CP fuel system to be used with a non Sierra CP host control system, via either an Ethernet AK protocol or analogue interface. This 4U 19" rack mountable fuel controller can be easily integrated into an existing control system cabinet, to allow control of fuel measurement, fuel temperature and pressure conditioning, and control of other CP in-cell ancillary equipment, as required.



Innovate to Differentiate.



FuelTrak 1000 & 3000

Gravimetric Fuel Measurement

Issue 4.1

INTRODUCTION



The FuelTrak-1000 and 3000 Gravimetric Fuel Measuring Systems are compact, high precision instruments for measuring specific fuel consumption of diesel and petrol/gasoline engines. The FuelTrak-1000's and 3000's wetted parts are all stainless steel and Viton, enabling standard reference and ethanol based fuels to be used.

The FuelTrak range is controlled and monitored either by a CADET V14 host, or the CADET V14 Fuel

Controller, which is detailed in a separate datasheet. The FuelTrak operates by filling the internal stainless steel weigher vessel with fuel. The CADET system will then record the net fuel removed from the vessel, over a set amount of time, and calculate the average fuel consumption. Once the weigher lower limit is reached, the vessel will refill with fuel and the process will be repeated.



SPECIFICATION

FuelTrak Model	Units	1000	3000
Compatible Fuel Types	-	Petrol, Gasoline, Diesel (For Reference Fuels Contact Sierra CP)	
Max Flow to Engine	kg/hr	300	1,800
Measurable Flow Rate*	kg/hr	0-200	0-600
Usable Tank Capacity	litres	1	3
Fuel Temperature Range	°C	0 - 65	
Accuracy	-	±0.05% of reading, ±0.03 grams	
Weigher Dimensions (HxWxD)	mm	330 x 230 x 180	600 x 310 x 180

*At maximum flow rate, weigher will empty in 15 seconds (maximum recommended for accurate measurement). The customer fuel supply flow rate should be substantially greater, to fill the weigher in minimal time. Please note flow rates have been calculated on Petrol/Gasoline density.

BENEFITS AND FEATURES

- Holding tank de-gasses spill back fuel
- Self calibrating with integrated mass calibration capability
- When run in hardware mode acts as a header tank
- Small size, wall or post mountable

APPLICATIONS

- Specific Fuel Consumption Measurements
- Special Fuels Research and Development
- Fuel Additives and Resultant Effects
- Emissions Certification Work

SYSTEM DESCRIPTION

The FuelTrak-1000 and 3000 systems are controlled and monitored by CADET V14, this records and displays (or outputs to cell controller) the data obtained. The fuel weighers use 20N and 50N loadcells respectively to measure consumed fuel. They also cancel any vibration mechanically, as the construction is stiff and has no moving parts. The benefits of this design include a high degree of linearity and a reduction of inaccuracies by not using a vibration dashpot. The fuel cells have volumes of 1 and 3 litres and are mounted underneath the loadcells. The fuel cell has four ports all connected by lightweight bellows. These ports are for Fuel Feed, Fuel Supply, Fuel Return and Vent.

Calibration is achieved by automatic removal of a 100gram (1000) or 480gram (3000) calibration weight on to the fuel vessel. The resulting change in the analogue output signal is used to calibrate the system at the prevailing fuel level. When the system is not configured for operation or CADET is not active the FuelTrak will run in a hardware only mode allowing the Control Unit to maintain the fuel between two preset levels, by opening and closing the fuel 'FILL' solenoid valve. This enables the FuelTrak systems to run as an in-cell header/day tank.

Steady State Fuel Measurement

When the FuelTrak measurement vessel is filled to its maximum the CADET V14's fuel component closes the fuel supply solenoid valve. After a short settling time, the net mass of fuel taken from the vessel is measured. Over the desired sampling time the CADET hardware samples the loadcell data at 10 kHz and returns the *averaged* value back to CADETV14 at up to 10 Hz. If the engine power is known under steady state conditions CADET V14 will also calculate the brake specific fuel consumption. When the FuelTraks fuel lower limit is reached measurement is halted while the vessel is automatically refilled by opening the fuel supply solenoid valve, allowing the process to restart.

Dynamic Fuel Measurement

The FuelTrak-1000 and 3000 are capable of monitoring fuel during a period of a test stage, or cycle, for a specific time as short as 100 ms. The stage, or cycle, is then repeated and the average fuel consumption rate calculated as a true dynamic reading.

OPTIONS

The table below shows the various configurations and options available with the FuelTrak gravimetric flow meters. One option from each row should be selected (multiples can be selected from 'Additional Equipment'). Images are for reference only.

FuelTrak Module	 A1 FuelTrak-1000		 A2 FuelTrak-3000	
Fuel Temperature Conditioning Units	B0 No Fuel Conditioning		 B1 FCU-1000 <i>See Separate Datasheet</i>	 B2 FCU-3000 <i>See Separate Datasheet</i>
Control Module	 C1 FuelTrak 1000/3000 Control Module		 C2 FuelTrak and FCU Control Module	 C3 FuelTrak Control Module (Upgradable to FCU Control)
Automation System	 D1 CADET Fuel Cards and Daughterboard		 D2 Fuel Controller - <i>See Separate Datasheet</i>	
Heat Exchangers	E0 No Heat Exchangers		 E1 Integrated Heat Exchangers	 E2 Loose Heat Exchangers
Additional Equipment (Contact Sierra CP for Further Details)	F0 No Options		 F1 Fuel Post (Stainless Steel and pre plumbed Versions Available)	 F2 Fuel Pressure Regulation <i>See separate datasheet</i>
				 F3 FCU Chiller

Each FuelTrak system will be supplied with the following:

- Fuel fill solenoid valve (for installation on the incoming fuel supply) with 1 metre loom to the control module
- 1 metre signal loom between FuelTrak Module and Control Module
- 5 metre power loom between Control Module and 110/230VAC single phase power supply (3 phase required with FCU-3000)
- 10 metre loom between Control Module and Automation System

Nonstandard loom lengths are available. Please make Sierra CP aware of this on order placement.

Sierra CP offer a wide range of fuel products including gravimetric meters up to 1,000 kg/hr, transient fuel meters up to 300 kg/hr, fuel temperature conditioning units, fuel pressure regulation, fuel dosing rigs, fuel controllers as well as offering custom fuel rig design and manufacture. Sierra products are also available for flow measurement of other fluids and gasses. Please contact Sierra CP for further details or refer to the specific datasheets.

CUSTOMER RESPONSIBILITIES

The customer should make available or prepare the following services:

- 110/230V Single phase power supply (3 phase if FCU-3000 is purchased)
- Fuel supply line
- Fuel return/spillback line
- Pipework between FCU and heat exchangers (if purchased)
- Fuel vent line
- Fuel pumps and filters, as necessary
- Installation of solenoid valve into fuel supply pipework
- Compressed air 2-5 bar, filtered and dry (required for calibration only)

Innovate to Differentiate.



FuelTrak Transient 100 & 300

Continuous Fuel Consumption Measurement

Issue 4.1

INTRODUCTION

The Transient FuelTrak fuel consumption meter is a technical development of the Sierra CP FuelTrak 1000 gravimetric fuel measurement system. The FuelTrak Transient enables continuous and dynamic fuel flow measurement as well as offering fuel density measurement.



The meter utilises two measuring techniques to determine and confirm the fuel consumption of the engine; gravimetric and coriolis. A high speed 2 way valve controls the fuel flow through the coriolis meter, such that the fuel level in the gravimetric tank is kept constant. The two measurement systems are linked together to attain the benefits that each system can offer, namely coriolis at 'normal' flow rates and gravimetric at low flow rates. They can also be used to verify each other's performance and operation for calibration purposes. The FuelTrak and other associated fuel hardware is controlled by a CADET system (an existing system, new system or fuel controller, see separate datasheets).

SPECIFICATION

		100	300
Maximum Consumption	kg/hr	100	300
Maximum Flow to Engine	kg/hr	300	
System instantaneous accuracy	%	± 0.5% for flows from 10kg/hr to 100kg/hr	± 0.5% for flows from 30kg/hr to 300kg/hr
System averaged accuracy	%	± 0.1%	
Density Measurement Range	kg/m ³	0 - 5,000	
Density Measurement Accuracy	%	± 2.0	
Compatible Fuel Types		Petrol, Diesel (For reference fuels contact Sierra CP)	
Temperature Range	°C	0 to 65	
Measurement Enclosure Dimensions Including Actuator (H x W x D)	mm	750 x 600 x 250	950 x 800 x 300
Control Enclosure Dimensions (H x W x D)	mm	400 x 400 x 200	
Pipe Connections		3/8" BSP(P) Female	

BENEFITS AND FEATURES

- High accuracy measurement
- Continuous fuel measurement capability
- Two measuring techniques allows cross referencing for calibration
- Fuel density measurement
- Bubble separation on return line type fuel systems
- Stainless Steel wetted parts for reference and special fuels
- Integrated fuel temperature conditioning heat exchangers (Supply, feed to engine and spillback from engine). FCU unit required to provide conditioned temperature circuit (see separate datasheet)
- Compact process unit allows positioning close to engine
- PID control

APPLICATIONS

- Specific fuel consumption measurements
- Special fuels research and development
- Fuel additives and resultant effects
- Emissions certification work

SYSTEM DESCRIPTION



The system provides all the existing features of the Sierra CP FuelTrak 1000 (see separate datasheet) gravimetric fuel measurement systems, such as bubble separation from returned fuel, together with continuous flow operation and measurement, fuel density readings and atmospheric fuel delivery.

The two measuring techniques of a standard steady state gravimetric fuel meter and a coriolis meter are utilised to determine the dynamic fuel consumption of the engine. The gravimetric fuel meter is connected to the engine's feed and spill return lines. The coriolis meter is connected to the supply port of the gravimetric fuel meter to measure the amount of 'make up' fuel required to maintain the mass of fuel in the gravimetric tank at 500grams (approximately half full). A rotary positional control valve allows fuel to pass through the coriolis meter into the measurement tank at the required rate to maintain the mass at 500grams. In this way any variation of mass seen in the measurement tank is corrected and measured by the coriolis meter.

The system is protected by a solenoid valve on the incoming supply line and level switches prevent fuel flow into the unit in the event of overfill. The all stainless steel heat exchangers fitted to the supply, feed and return lines can be connected to the Sierra CP Fuel Conditioning Unit (See separate FCU 1000 & 3000 datasheet). When connected to a suitable chilled water supply the FCU will provide conditioning of the fuel in the system at three points, hence maintaining the correct temperatures for reproducibility of tests or to meet relevant standards.

OPTIONS

The table below shows the various configurations and options available with the FuelTrak transient flow meters. One option from each row should be selected (multiples can be selected from 'Additional Equipment'). Images are for reference only.

FuelTrak Module				
	A1 FuelTrak Transient 100		A2 FuelTrak Transient 300	
Fuel Temperature Conditioning Units*				
	B0 No Fuel Conditioning		B1 FCU-1000* <i>See Separate Datasheet</i>	
				
			B2 FCU-3000* <i>See Separate Datasheet</i>	
Control Module				
	C2 FuelTrak and FCU Control Module		C3 FuelTrak Control Module (Upgradable to FCU Control)	
Automation System				
	D1 CADET Fuel Cards and Daughterboard		D2 Fuel Controller - See Separate Datasheet	
Additional Equipment (Contact Sierra CP for Further Details)				
	E0 No Options		E1 Fuel Post	
				
			E2 Fuel Pressure Regulation <i>See Separate Datasheet</i>	
				
			E3 FCU Chiller	

*FCU-1000 is suitable for the FuelTrak 100. FuelTrak 300 can function with either FCU-1000 or FCU-3000, depending on the temperatures and maximum fuel supply and spillback rates required.

Please contact Sierra CP with your specification for further details.

Each FuelTrak system will be supplied with the following:

- Fuel fill solenoid valve (for installation on the incoming fuel supply) with 1 metre loom to the control module
- 1 metre signal loom between FuelTrak Module and Control Module
- 5 metre power loom between Control Module and 110/230VAC single phase power supply (3 phase required with FCU-3000)
- 10 metre loom between Control Module and Automation System

Nonstandard loom lengths are available. Please make Sierra CP aware of this on order placement. Sierra CP are able to re-design the FuelTrak Transient unit to support custom specifications, such as increased spillback or consumption capability.

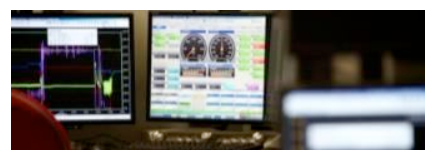
Sierra CP offer a wide range of fuel products including gravimetric meters up to 1,000 kg/hr, transient fuel meters up to 300 kg/hr, fuel temperature conditioning units, fuel pressure regulation, fuel dosing rigs, fuel controllers as well as offering custom fuel rig design and manufacture. Sierra products are also available for flow measurement of other fluids and gasses. Please contact Sierra CP for further details or refer to the specific datasheets.

CUSTOMER RESPONSIBILITIES

The customer should make available or prepare the following services:

- 110/230V Single phase power supply (3 phase if FCU-3000 is purchased)
- Fuel supply line
- Fuel return/spillback line
- Pipework between FCU and FuelTrak enclosure (if FCU is purchased)
- Fuel vent line
- Fuel pumps and filters, as necessary
- Installation of solenoid valve into fuel supply pipework

Innovate to Differentiate.



Fuel Conditioning Units 1000 & 3000

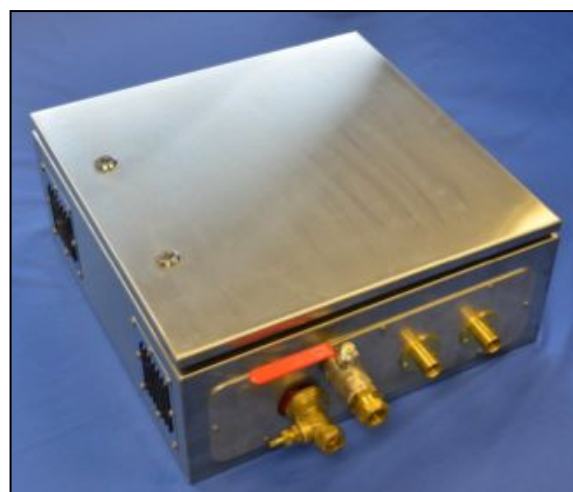
Fuel Temperature Control

Issue 4.1

INTRODUCTION

The Sierra CP Fuel Conditioning Unit is designed to enhance the features of the FuelTrak-1000, 3000, Transient FuelTrak or other 3rd party Fuel Measurement Systems. The FCU provides computer controlled fuel supply temperatures, to either combat extreme ambient conditions, high fuel return line temperatures or to match specific test requirements.

The FCU provides a temperature conditioned, pump driven process loop, which is fed into heat exchangers connected to the engine fuel supply line and optionally the spillback and fuel tank supply lines. The FuelTrak Transient and the FuelTrak 1000 & 3000 (as an option) have these heat exchangers integrated into the measurement enclosure, minimising installation pipework required.



SPECIFICATION

FCU Model		1000	3000
Maximum Fuel Temperature	°C	60	
Minimum Fuel Temperature	°C	10 Above Chilled Supply Temp	
Immersion Heater Power	kW	3	9
Cooling Power	kW	3	7
Process Enclosure Size (H x W x D)	mm	600 x 600 x 250	800 x 800 x 350
Control Enclosure Size (Common between FuelTrak and FCU)	mm	400 x 400 x 200	
Electrical Supply Required		230V Single Phase	380V Three Phase

BENEFITS AND FEATURES

- Condition Fuel using set points from CADET or 3rd party control system (Via the Sierra CP Fuel Controller)
- Integrate into existing fuel systems
- Enclosure allows wall or post mounting
- Common control enclosure between Sierra CP FuelTrak and FCU systems
- Conditioned process loop means fuel is not heated/cooled directly

APPLICATIONS

- Emissions Certification Work
- Simulating various environments
- Standardisation of test conditions

SYSTEM DESCRIPTION

The Control Enclosure marshals the mains switching and i/o associated with the control of the Process Enclosure. The Process Enclosure requires one set of Feed and Return lines for the process fluid circuit and one for the Chilled Water Circuit, therefore minimising the in-cell pipework. The temperature in the header tank is maintained or adjusted by directing the conditioning loop intake to one of two circuits. To cool the process loop, fluid is diverted through the chilled circuit's heat exchanger before return to the header tank. To warm the process loop water circuit, the heat exchanger is by-passed and the immersion heater in the header tank is turned on. A PRT mounted in the header tank constantly monitors the temperature of the process water. A water level safety switch in the header tank prevents the Immersion Heater being operated when there is insufficient fluid, and provides feedback to the operator.

The process water from the header tank is fed through a second Heat Exchanger to cool or warm the fuel from the FuelTrak (or other) fuel conditioning unit, before it is fed to the engine. It is assumed that the fuel delivery temperature at the engine is already monitored (by CADET or another system). This channel is required to allow CADET to adjust the conditioning accordingly. As an option Sierra CP can supply a suitable PRT probe and the associated signal processing hardware.

OPTIONS

If purchasing the FCU with a FuelTrak meter then please see the 'Options' table in the relevant datasheet for specific product selection data. If purchasing the FCU for use with an existing FuelTrak product, or other fuel measurement system, then Sierra CP are able to offer the following options:

- Fuel Controller (This will be required unless the customer has an existing CADET system, please see the Fuel Controller Datasheet for further details)
- Heat exchangers to integrate into fuel supply ductwork
- Fuel Delivery PRT probe and associated CADET hardware
- Chiller units – to supply chilled water for cooling process

CUSTOMER RESPONSIBILITIES

The customer should be responsible for providing the following services:

- Chilled fluid circuit (capacity will be advised on order placement, based on specific testing requirements). Generally between 1 to 10°C supply with 3kW heat extraction for FCU-1000 and 7kW for FCU-3000 (Sierra CP can provide a suitable unit if required)
- Fuel heat exchangers as required
- Pipework, as required (Sierra CP can offer pre plumbed options)
- Electrical supply
- Fuel delivery temperature value (Sierra CP can provide a PRT probe and hardware if required)
- Conditioning circuit fluid (water and glycol mix recommended)

Innovate to Differentiate.



Fuel Pressure Regulation

Issue 4.1

INTRODUCTION

The Sierra CP Fuel Pressure Regulation Unit has been designed to allow a range of settable fuel delivery pressures to be achieved. The pressure setpoint inputted by the customer (either directly entered into CADET, or sent to the fuel controller) is controlled by an electro pneumatically actuated regulator valve and an pressure transducer to provide pressure feedback. A PRT probe is also integrated to provide fuel temperature feedback. A pump on the inlet is used to provide flow and to increase the fuel pressure, prior to regulation.

An integral manual selector can bypass the Fuel Pressure Regulator hardware when not required. When bypassed, fuel pressure and temperature readings will still be taken.



SPECIFICATION

Maximum Delivery Flow Rate	180 kg/hr
Pressure Control Range	0.5 Bar to 5.0 Bar (Gauge)
Steady State Control Regulation	± 0.05 Bar
Compatible Fuels	Gasoline and Diesel
Fuel Connections	½" Female BSP
Dimensions (H x W x D)	400 x 300 x 200 mm

BENEFITS AND FEATURES

- Combats supply pressure variations
- CADET Controlled
- Delivery pressure and temperature logged

APPLICATIONS

- Fuel pump simulation
- Regulate varying supply pressures

SYSTEM DESCRIPTION

The regulator consists of a constant flow automotive fuel pump. The fuel flows from the pump to the manifold block which is used to mount the pressure and temperature sensors. The constant flow rate from the pump is typically greater than the engine consumption. This over supply of fuel results in an increase in pressure seen at the regulator. When the resultant pressure is achieved the excess fuel is by-passed through the regulator to the fuel meter return line.

Adjustment of the fuel pressure is achieved by way of an Electro Pneumatic Air Pressure fitting. This allows an E/P device to control the air pressure acting on the regulator diaphragm. Any spill back fuel from the engine is fed back into the pressure control unit, and is then fed to the fuel meter return line.

The pressure regulation unit is supplied with a control box which interfaces with CADET Control system to allow control of the fuel pressure. A solenoid valve is fitted on the engine feed connection to allow cutoff of the engine fuel supply for safety.

OPTIONS

A manual fuel control board is also available, whereby the delivery pressure is set by manually adjusting the pressure regulator. A delivery pressure gauge is supplied to determine fuel pressure. Sierra CP can supply units with increased flow rates or higher supply pressures. An existing CADET system, or CADET Fuel Controller (See separate datasheet) will be required to control the unit.

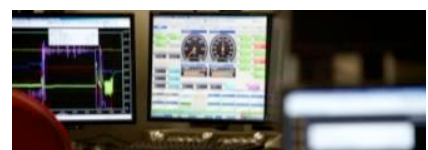
CUSTOMER RESPONSIBILITIES

The customer should be responsible for providing the following:

- Connection to supply and engine fuel lines
- 110/240V power
- Compressed air supply – instrument grade, dry, dust and oil free

The fuel pressure regulator should be installed downstream of fuel measurement and conditioning units.

Innovate to Differentiate.



Fuel Dosing Rig

Precision Fuel Additive Control and Consumption Measurement

Issue 4.1

INTRODUCTION

The Sierra-CP fuel dosing rig is designed to supply a continuous, precise, controllable dose of additive/additives to fuel for delivery to an engine or vehicle under test. The system is designed to provide a continuous supply of dosed fuel, with high precision fuel consumption measurement. The dosing rig measures a batch of fuel to the required dosing ratio. This is then mixed and deposited in an integrated FuelTrak 1000 gravimetric fuel measurement meter, which allows the fuel to be delivered to the engine as required. While the mixed fuel is being consumed by the engine another batch of fuel is being automatically pre mixed, such that continuous dosed fuel delivery is achieved.

BENEFITS AND FEATURES

- Fuel dosing to required mixture levels
- Dosing levels can be varied test to test
- Large pre dosed fuel stores are not required
- Gravimetric fuel consumption measurement
- Portable trolley based unit
- Multiple control modes
- All wetted parts are stainless steel
- Fuel delivered at ambient pressure

APPLICATIONS

- Catalyst testing
- Emissions testing
- Injector testing
- Additive and consumption testing



SPECIFICATION

Dosing	
Additive/Dosed Fuel Measurement Accuracy	±0.03 g
Control Accuracy of High Dose Fuel/Additive Addition	±1.7 ml
Control Accuracy of Fuel Addition	<2% of fuel mass required to achieve correct mixing ratio between fuel and high dose fuel/additive
Usable Dosing Vessel Capacity	1 Litre
Fuel Consumption	
Delivered Fuel Metering Accuracy	±0.05% of reading, ±0.03 grams
Measureable Flow Rate	0 - 200 kg/hr
Maximum Fuel Flow to Engine	300 kg/hr
Fuel Temperature Range	0 - 65°C

SYSTEM DESCRIPTION

The fuel dosing system is based on two of Sierra CPs high precision FuelTrak-1000 gravimetric fuel measurement meters. The dosing rig is connected to the customer's standard fuel supply system. Prior to testing a stainless steel storage vessel is filled with either a highly dosed fuel mixture (of known dosed ratio) or the pure additive/additives mixture, dependant on the final additive concentration required.

A valve on the standard fuel supply is opened to allow the FuelTrak measuring vessel to part fill. The additive or highly dosed fuel is then added into the measuring vessel at a controlled rate. Finally the measurement vessel is then topped up with standard fuel to achieve the desired dosing ratio. Once this is achieved the mixture is continually circulated through the first measuring vessel using a stirring pump, which allows the additive to be distributed evenly. Dosed fuel for the engine is teed off the stirring circuit into the second measurement vessel, which is then delivered to the engine.

The dosing rig can operate in various modes and allows continuous mixing, delivery and measurement of dosed fuel to the engine (until the external additive or highly dosed fuel supply is exhausted). The rig can be switched to allow operation of the rig as a standard FuelTrak-1000 fuel meter (separate datasheet available), if dosing is not required for certain tests.

Control of the Rig is via a CADET control system; this can either be a component within a complete CADET Control, Automation and Datalogging System or the CADET Fuel Controller (separate datasheet available) which would communicate with the customers test cell control system via an Ethernet AK interface. The rig is portable, meaning it can be moved from cell to cell as required (requires stand alone fuel controller, or CADET system with fuel controller component installed in each cell).

OPTIONS

Sierra CP specialise in bespoke systems, please contact Sierra CP with any dosing requirements to receive further information on the options and solutions available.

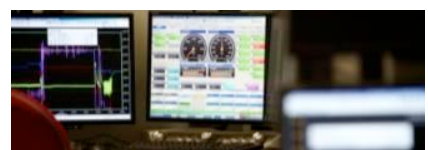
The fuel dosing rig can be combined with Sierra CPs range of fuel temperature and pressure conditioning modules to allow standardisation or controlled variation of test cycles (separate datasheets available). Sierra CP can provide fuel density measurement within the rig as an option.

CUSTOMER RESPONSIBILITIES

The customer should make available of prepare the following services:

- Single phase electrical power supply
- Fuel supply lines
- Engine supply and return lines
- Dosed fuel supply or additive supply
- CADET control system or fuel controller, with the necessary free control and datalogging channels

Innovate to Differentiate.



Independent Fuel Controller

Issue 4.1

INTRODUCTION

The Sierra CP Independent AK-Fuel Controller has been designed in response to the requirement to use models from Sierra CP's comprehensive range of Fuel Measurement and Conditioning system with non Sierra CP host controllers. This controls Sierra CP fuel equipment and relays data to 3rd party host controllers via an Ethernet TCP/IP connection. The fuel controller has been packaged into a 4U 19" unit which can be rack or desk mounted.



The Sierra CP Fuel controller can function with the following Sierra CP equipment:

Transient FuelTrak-100	Instantaneous fuel measurement for transient testing
Transient FuelTrak-300	
FuelTrak-1000	Averaged fuel measurement for steady state testing
FuelTrak-3000	
FuelTrak-9000	
FCU-1000	Stable temperature setpoint of delivered fuel
FCU-3000	
Fuel Pressure Regulation Board	Stable pressure setpoint of delivered fuel
VFS-1000	Vehicle fuel delivery consumption meter
Fuel Dosing Rig	Controllable continuous real time fuel additive dosing
Cooling Post/Valve Manifold	Cooling control for engine oil, coolant and intercooler circuits
Throttle Actuators	Mechanical throttle actuator for engine/pedal actuation
Air/Exhaust Back Pressure Valves	Closed loop pressure control of air inlet and/or exhaust valves
Cell Services	Control of cell services equipment such as blast coolers and chillers

BENEFITS AND FEATURES

- Sierra CP equipment can be used in any test cell
- Multiple devices can be run from a single controller
- Windows based operating system with CADET V14 Component software
- Remote support can be provided if a fault develops
- Straight forward AK command structure
- Analogue output option at additional cost

SYSTEM DESCRIPTION

The Fuel Controller is based on the Sierra CP CADET control hardware with an integrated small format industrial PC, based on the latest specification of the standard CADET system controller, running a 'component' version of CADET V14 software. This controls all aspects of the Fuel Meters and Conditioners to the same high performance standards of a full CADET system, but allows interfacing to alternative test system hosts using an AK protocol over Ethernet TCP/IP.

The fuel controller is designed to be able to control other Sierra CP in-cell equipment such as cooling modules, air and exhaust back pressure valves, with the addition of the relevant standard Sierra CP control and datalogging cards and daughterboards.

A single fuel controller can be used to control multiple fuel and in-cell products. Please specify the products which require control when requesting quotation.

The controller is based on the latest version of the full CADET software. Therefore the controller benefits from the latest software updates and enhancements. In the event of a fault developing Sierra CP can provide phone and remote assistance as part of a service and maintenance contract package; further details available on request.

OPTIONS

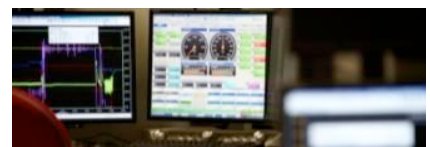
Fuel controllers are based on Sierra CPs CADET control cards, therefore systems will be built to match the equipment the customer wishes to use. This can be expanded in the future as additional equipment is purchased.

Sierra CP are able to provide Fuel Controllers with 0-10V/4-20mA analogue outputs and digital outputs in addition to, or instead of the AK protocol. Please contact Sierra CP direct with your specific requirements for further details.

CUSTOMER RESPONSIBILITIES

The customer will be responsible for providing single phase power (110/230V) to the fuel controller. The customer should also provide a suitable monitor, keyboard and mouse for initial setup of the system. Sierra CP can provide the customer with a copy of the AK protocol; it is the customer's responsibility to correctly configure the host system to interface to the fuel controller. The customer should ideally provide an internet connection, so that remote commissioning of the controller can be carried out.

Innovate to Differentiate.



Test Cell Services

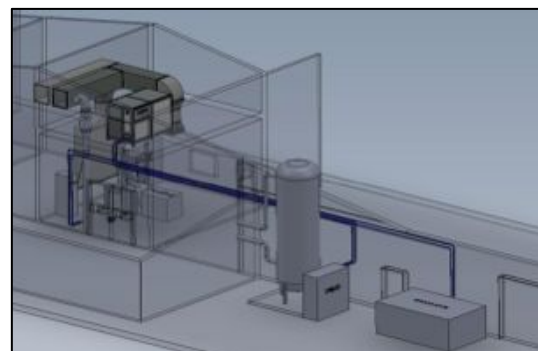
Cell and Facility Services to Support
Automotive Test Cells and Facilities

TEST CELL SERVICES

Driven by increasingly stringent legislation around the world, particularly in the area of emissions validation and development, there is a need to minimize test variability by reducing, controlling or eliminating all external influences that effect the accuracy and repeatability of test results. The control and repeatability of test cell ventilation and engine combustion air conditioning are recognized as key external influences that can have a significant impact on the test specimen and the results obtained.

Sierra CP is unique in our ability to offer a suite of innovative modular solutions in this highly specialized field. This enables existing test cells to be upgraded, or new conditioning systems to be integrated into existing or new turnkey installations. Specific solutions include cell ventilation, exhaust extract systems, combustion air handling, intake air mass flow measurement, exhaust back pressure control, and engine fluid temperature (fuel, oil, coolant, intercooler).

As part of a turnkey package Sierra CP are able to provide the associated site services required for effective test cell operation, including chilled water circuits required for air and fuel conditioning units, bed water circuits required for engine and dynamometer cooling services, steam generation equipment, required for re-humidification of engine and test cell air. Sierra CP are able to provide these services in a wide range of capacities, ranging from the smallest of test cells to complete facility services. Sierra CP are able to offer complete test cell design and build facilities as part of a turnkey package.



Innovate to Differentiate.



Combustion Air Handling Unit (CAHU) Temperature, Pressure and Humidity

Issue 4.1

INTRODUCTION

The Combustion Air Handling Unit (CAHU) conditions the available ambient air supply and generates output air of controllable pressure, temperature and humidity levels (humidity control optional). Humidity is controlled by the introduction of steam, either from an internal generator or a customer steam supply. This air provides a standard operating condition for the engine/vehicle, and can be used for emissions work, and for standardising the engine intake air conditions for mapping or optimisation work. The use of a CAHU can also reduce the test days lost due to adverse atmospheric conditions. The CAHU is controlled by a system controller PC running CADET V14 Cell Services software. This can either be configured for standalone operation, with setpoint values being manually inputted, or can receive setpoints from a non Sierra CP test cell host system via an AK TCP/IP protocol.



SPECIFICATION

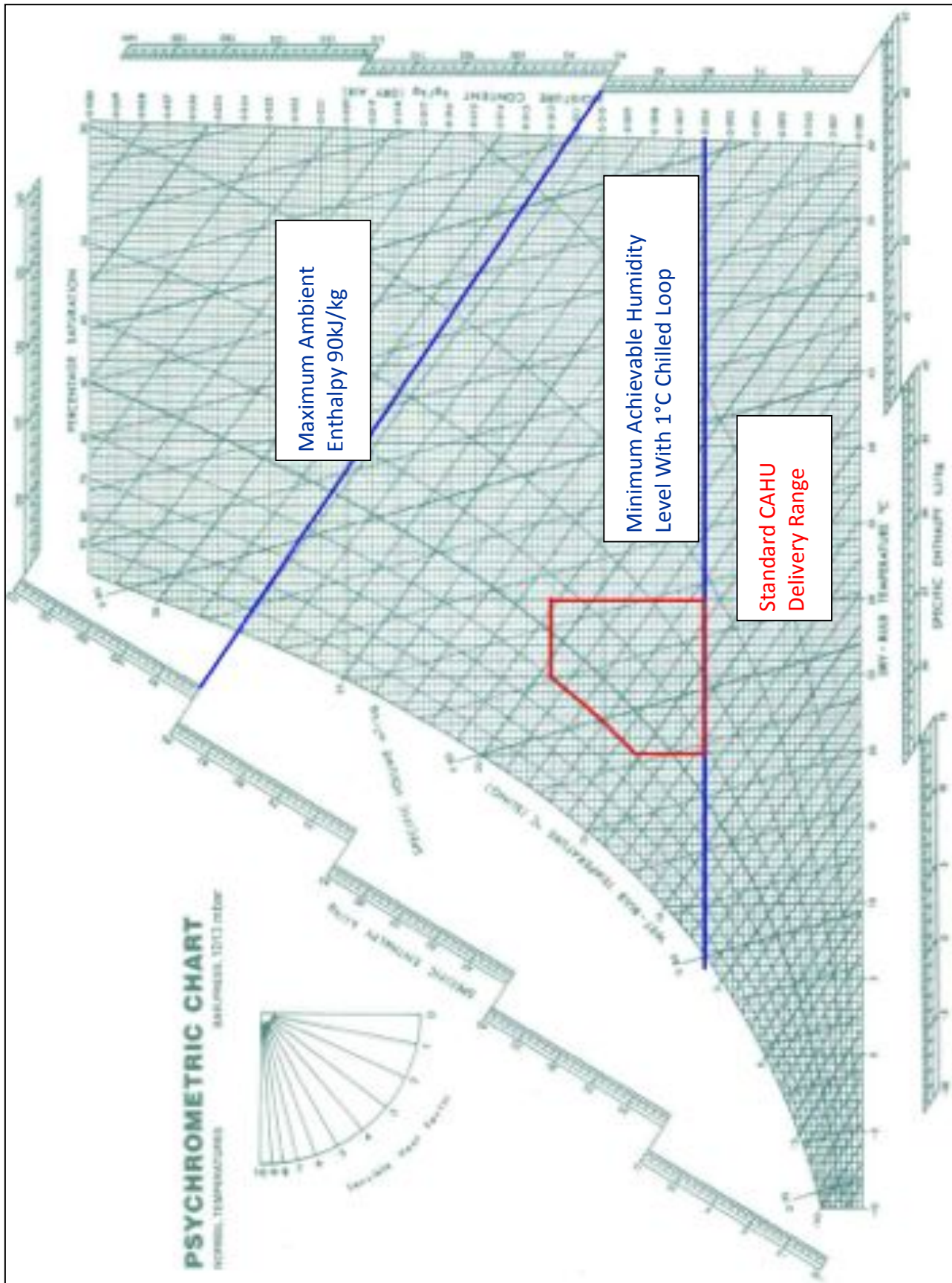
Below are the specifications for the standard CAHU units. Please note that custom CAHUs are possible with expanded delivery conditions, flow rates, accuracies and physical layouts. Please contact Sierra CP with your specification for further details. Details on Sierra CP's high performance 'Motorsport' specification CAHU can be found in a separate datasheet, available on request.

Conditions at CAHU Outlet	Units	Value
Supply Flow Rate		
Max Engine Flow Rate	kg / hr	1,000 1,500, 2,500 and 3,500
Min Engine Flow Rate (to keep duct conditioned to $\pm 1\text{C}$)	kg / hr	250
Output Temperature		
Output Temperature Range*	$^{\circ}\text{C}$	20 – 30 (Standard) 15 – 40 (Available as an option, Humidity Control Below 20°C is limited)
Steady State Accuracy	$^{\circ}\text{C}$	± 1.0
Output Humidity**		
Absolute Humidity*	g/kg	6 – 12 (Standard) 6 – 18 (Optional, higher humidity are also achievable on request)
Relative Humidity*	% RH	30% - 60% (Standard at 25°C)
Steady State Accuracy	% RH	$\pm 5\%$ (3% Typical)
Humidity Supply Duty		100% with facility steam 95% with on-board steam
Output Pressure		
Minimum Pressure	mBar	960 (Standard)
Maximum Pressure	mBar	1050 (Standard)
Steady State Accuracy	mBar	± 1.0 of Setpoint
Transient Accuracy	mBar	± 1.0 of Setpoint with 1 sec Step Change
Delivery and Dump Line Outlet Locations		Top, Front or Side, depending on customer requirement
Input Air Conditions for Normal Operation		
Ambient Enthalpy	kJ/kg	<90
Minimum Temperature	$^{\circ}\text{C}$	3 (Duct heaters can be installed for operation at lower ambient temperatures)
Ambient Pressure	mBar	920 to 1050 Required setpoint may not be achievable when operating at high/low extremes
Physical Dimensions		
W x D x H	M	2.8 x 1.6 x 1.8
Weight – approximate, models vary	kg	1,200 – 1,500

*See delivery condition chart for standard output operating window

**If humidity control is not requested, then the humidity of combustion air will be 6g/kg or ambient, whichever is lower

STANDARD DELIVERY RANGE



BENEFITS AND FEATURES

- Control of Pressure, Temperature and Humidity levels
 - Only conditions air for the engine
- Simulate alternative air conditions, such as:
 - Race Circuits
 - Foreign Countries Ambients
- Fast condition response for transient work
 - All potential air is conditioned ready for use
- Self contained unit
- Send Set-points from an Existing Test Controller
- Two sided access for ease of installation, operation and servicing
- Four sizes as standard, 1000, 1500, 2500 and 3500 kg/Hour,
 - Passenger Vehicles, Race Engines and Heavy Duty Vehicles
- Custom designs available
 - Extended operating ranges
 - Altitude simulation versions
 - Custom size envelopes
 - Turbo simulation units
- Engine protection under fault conditions
- Stand alone or Ethernet based control

APPLICATIONS

- Standardise intake air for repeating experiments
- Power pass off tests
- Emissions certification work
- Conditions adverse ambient's to within the range of correction factors

SYSTEM DESCRIPTION

The most accurate method of conditioning the air to the required level is to control the re-heating and re-humidification of the ambient air to achieve the necessary output. In order to do this, the ambient air is passed through the primary coil and is cooled to a base temperature and humidity level. This initial cooling of the air causes a large proportion of the water content to condense out. The result is cold relatively dry air that can then be conditioned by the CAHU.

Re-Humidification (if required) is achieved using a flow of high temperature steam either from an external steam supply provided by the customer, or an internal steam generator built into the CAHU. A dual control valve with three stages of turndown controls the flow rate of this steam. It is injected into the ductwork just before the first fan. The steam mixes with the combustion air while passing through the fan; this system gives efficient absorption of the steam into the combustion air, increasing the humidity level as required. If humidity control is not required, then air will be supplied at the base humidity level (or ambient if lower).



Air flow and pressure rise is created with a high-speed centrifugal fan. The fan is capable of raising the combustion air pressure by up to 120mBar (12kPa) above the air inlet pressure.

During pressure generation the fan generating the positive pressure 'heats' the air by several degrees C, due the adiabatic work done on the air. This heating effect during processing of the air is monitored and used to reduce the amount of re-Heating that is required. Additional heating is performed by electric heater coils mounted in the ductwork of the CAHU, these are switched ON in banks by the controller as necessary.

The airflow passes into a final delivery plenum. Two butterfly valves regulate the plenum pressure, one regulates inlet flow and one regulates the dump flow to atmosphere, and hence can adjust the pressure in the plenum to the required setpoint. The delivery port is then coupled directly to the engine.

Under fault conditions the pressure plenum is protected by an under-pressure relief system. Following activation, the engine will draw air from the atmosphere, even though it may not be of the required conditions, it will eliminate potential harm to the engine and CAHU. As negative pressure generation is required because the ambient air pressure may be higher than the required output air pressure, a second centrifugal fan in the CAHU is used to create a depression in the delivery plenum, seen at the CAHU outlet.

The CAHU is controlled by the Sierra CP CADET V14 Cell Services control tab, running on a system controller PC separate from the CAHU (communication via Ethernet). The I/O circuitry built into the CAHU electrical cabinet is wired to accept the control of the exhaust back pressure valve which can be used to provide a fixed exhaust back pressure. It is only possible to operate the exhaust at a pressure above atmospheric pressure as the dilution system has limited negative pressure capability.

OPTIONS

Sierra CP can offer custom designed CAHUs to meet specific customer requirements such as:

- Expanded temperature and humidity ranges
- Altitude simulation with low pressure ranges
- Weatherproofed units for external installation
- Enhanced transient stability for motorsport applications
- Custom intake/extract port locations

Sierra CP can offer various combustion air handling units, such as Temperature or Temperature and Humidity versions. Sierra CP also offer a boost rig which can be used to simulate high pressure turbochargers. Details of both arrangements can be found in separate datasheets.

In addition to CAHUs, Sierra CP can provide a variety of associated products and services:

- Intake air flow meters (see AirTrak datasheet for further details)
- Exhaust Back Pressure Simulation (see EBPV datasheet for further details)
- Associated chiller units
- CAHU and ductwork installation

CUSTOMER RESPONSIBILITIES

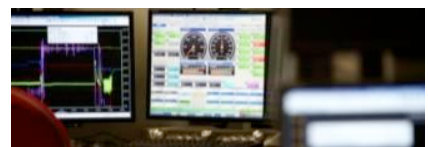
The customer should make available or prepare the following services:

- 1°C chilled coolant loop (Sierra CP can quote for a suitable chiller unit if required)
- Electrical Power Supply, 380-415V (3 phase + Neutral) 50Hz to CAHU electrical enclosure
- Water to Humidifier Unit (either tap water or demineralised) or steam supply
- Condensate drain
- Ductwork to the engine (smooth bore – thermally lagged)
- Ductwork from CAHU dump line

CAHU Flow Rate	kg/hr	1,000	1,500	2,500	3,500
Chilled Water (1°C Supply)					
Minimum Fluid Flow Rate (>3 Bar)	Litres/s	2.0	3.0	5.2	7.8
Maximum Heat Rejection	kW	24	35	60	89
Water/Steam Supply Rate	Litres/hr	17	25	42	58
Electrical Current (380-415V, 50Hz 3ph+N+E)	Amps	100	120	170	230
Ductwork Diameter	mm	150	150	150	200

Figures are for reference only and are based on a Maximum Ambient Enthalpy of 90kJ/kg at sea level with a supply voltage of 380V. Customer specific CAHU requirements will be confirmed during the project phase.

Innovate to Differentiate.



Ventilation Systems

Test Cell Conditioning

Issue 4.1

INTRODUCTION

Sierra CP offer bespoke cell ventilation solutions for automotive test cells. Ventilation systems can be designed to fit around design constraints of existing test cells, or can be designed as part of complete turnkey test cell installations. Sierra CP ventilation systems generally provide test cell temperature and pressure regulation.

The key components of a typical ventilation system are:

- Intake, extract and recirculation ductwork
- Inverter driven axial circulation fans on intake and extract
- Diverter louvers and actuators
- Heater elements
- Fire dampers
- Removable ductwork section for the future installation of cooling coils
- Cover grills
- Acoustic elements (option)
- Electrical enclosure connected to CADET cell services system controller



The volumetric flow rate of ventilation ductwork is based on the power capability of the largest engines the customer wishes to test and any additional treatment systems or hardware within the test cell. Due to inverter driven fans being used, the flow rate can be reduced for lower capacity engines using the same system.

BENEFITS AND FEATURES

- Heating and cooling options
- Fire safety shutdown
- Recirculation system reduces heating demand and offers higher precision control
- Pressure and flow rate control

APPLICATIONS

- Engine test
- Vehicle test
- E motor and hybrid testing
- Test condition standardisation
- Varying ambient simulation



SYSTEM DESCRIPTION

Sierra CP can supply recirculation ductwork as well as traditional intake and extract ventilation systems. On a colder day this can reduce the amount of duty required from the heater elements, as ambient air can be mixed with re-circulated air (warmed by the engine) to allow a stable cell temperature to be maintained. The recirculation ductwork also enables test cell temperature soaking prior to testing, as air can be repeatedly heated or cooled (with the addition of cooling coils) during recirculation as required.



Sierra CP use 2 inverter driven axial circulating fans with the standard ventilation system design, this allows flow rates to be varied whilst maintaining test cell pressure.

Control of the ventilation system is by the CADET V14 ventilation component which is either installed on the CADET test cell or facilities system controller. This can be operate as a stand-alone unit or receive setpoints from a CADET or 3rd party test cell host via an Ethernet AK protocol.

OPTIONS

Due to the bespoke nature of Sierra CP ventilation systems any requirements requested by a customer can be accommodated. Options such as humidity control (above ambient), fire dampers, air flow meters and custom air filtering can be accommodated.

Sierra CP are able to integrate cooling coils into ventilation ductwork to allow cell temperatures below ambient to be achieved. This may be required for test cell temperature pre-soaking, or to allow lower than ambient cell temperatures to be maintained during engine operation.

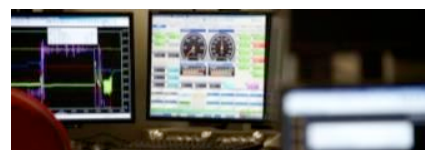
CUSTOMER RESPONSIBILITIES

In general the customer should be responsible for providing the following:

- Compressed air for damper actuation
- 3 phase power to the control enclosure
- Chilled fluid circuit, 1°C advised (if cooling coils are installed) and glycol

The specifics of the services required and the extent of Sierra CPs installation responsibilities will be further discussed during the project phase. Sierra CP can provide the services required as necessary.

Innovate to Differentiate.



Test Cell and Facility Services

Products and Services for Turnkey Installations

Issue 4.1

INTRODUCTION

Sierra CP are able to supply and install the cell support services required for test cell installations; either as separate items, upgrades or as part of a turnkey project. This includes bed and chilled water circuits, ventilation systems (see separate datasheet), exhaust extracts systems, compressed air, steam generation and fire suppression systems. Sierra CP can also design and construct test cells in either blockwork or prefabricated panels.

TEST CELL DESIGN AND MANUFACTURE

Sierra CP are able to design and build test cells to meet most customer specifications. Typically this will be a structure within a larger warehouse type building. As part of a test cell design and build Sierra CP can provide the following:

- Test cell and control room structure
- Acoustic linings
- Acoustic doors and windows
- Heating and lighting
- Single and three phase electrical distribution
- Integrated cranes or lifting systems
- Structural surveys/design input

For further information please contact Sierra CP with your requirements.



BED WATER

Most engine test cells generally require a bed water cooling system. This is for the various engine cooling circuits, such as oil, water and intercooler circuits (see the Sierra CP valve manifold and cooling post datasheet) as well as some dynamometer cooling circuits. Sierra-CP are able to supply dry air blast coolers for external installation to provide cooling water. These typically result in a cooling loop of 10°C above ambient (35-40°C supply is typical for the UK), sized according to the



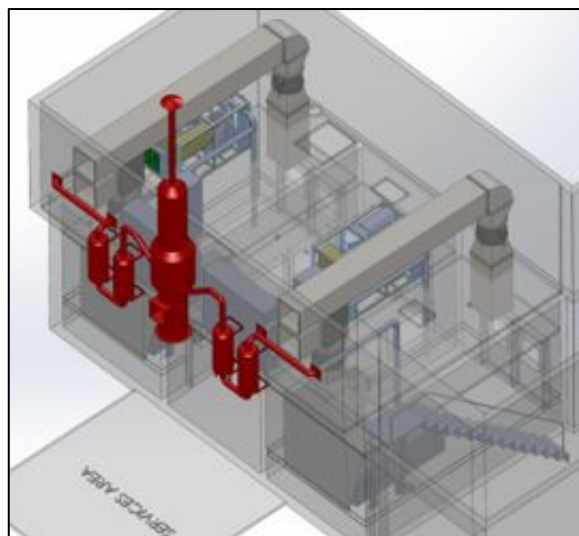
customers heat extraction requirements. Sierra CP normally supply inverter driven cooling fans as these increase the efficiency of the cooler, whilst keeping the noise level to a minimum. Sierra CP can provide complete integration of these systems on a bed by bed or facility basis, including pipework, lagging, pump sets and control valves, with facility control provided by CADET.

CHILLER UNITS

Sierra CP are able to provide a range of chilled plant equipment, ranging from 3kW (rated for the Sierra CP FCU-1000) to 100kW+ (rated for the larger CAHU and vent) to 2,000kW (multiple cell facilities) heat extraction. The chiller units are typically used to provide a chilled loop (generally 1°C) required for CAHU, FCU and ambient air cooling in ventilation systems. Chiller units can be specified for internal or external installation and will be sized according to the customers chilling requirements. Sierra CP can provide complete installation, including pipework, lagging, pump sets and control valves.

EXHAUST EXTRACT

Sierra CP are able to provide and install custom designed exhaust extract systems for new or existing test cells. A standard exhaust extract system would consist of fixed ductwork with a flexible connection to the engine. A silencer and bifurcated fan with dilution system would generally be provided to aid the extraction of the air, whilst reducing the noise and temperature levels. Sierra CPs Exhaust Back Pressure Valves (see separate datasheet) can be integrated into the ductwork as required.



COMPRESSED AIR

Sierra CP can provide and install compressed air supplies (typically 8 Bar) required for turbo boost simulation rigs. As part of complete turnkey test cell installation Sierra CP are also able to install instrumentation grade compressed air supplies, required for various test cell ancillary equipment.

STEAM GENERATION

Sierra CP are able to supply and install steam boilers, as required on site. These may be used to supply multiple CAHU units for steam humidification (it is generally more cost effective for multiple CAHU units to have external steam humidification and also provides 100% CAHU duty) or for other onsite services such as steam water heating etc. Sierra CP would also recommend the use of a reverse osmosis water supply, as this eliminates any salts and sediments in the steam supply, which can clog or damage equipment. Sierra CP are able to supply and install RO filtration equipment as required.

FIRE SUPPRESSION SYSTEMS

Sierra CP are able to supply fire suppression systems with temperature, flame and hydrocarbon detection options, suitable for engine or vehicle testing. The systems supplied are generally based on a high pressure water mist design, as this causes the least damage to any electrical systems within a test cell. Sierra CP can supply passive (filament driven) or active (sensor and volts free contact) system to suit the customer's requirement. Water can either be provided by a mains water system (with the use of a pump compressor) or a water and compressed air tank based system.

Innovate to Differentiate.



Transient Single Cylinder Test Systems

Issue 4.1

INTRODUCTION

Sierra CP have developed a complete range of test cell equipment specially tailored towards single cylinder engine research and development. Sierra CP offer a range of standard transient AC dynamometers with regenerative drive to allow transient motoring and absorbing of a single cylinder engine. The engine and dynamometer are generally mounted to a common test frame.

Sierra CP offer a range of complimentary sub systems to enhance the testing of single cylinder engines. Sierra CP can offer:

- Oil and coolant conditioning circuits
- Boost simulation systems
- Exhaust Back Pressure Simulation
- Fuel measurement and conditioning circuits
- Datalogging, expandable to over 1,000 physical channels

Sierra CP are able to provide a boost rig which will allow simulation of turbo pressures of up to 5 bar with temperature conditioning. This allows research to be carried out into the effect of high boosting turbo and super chargers on engines. Exhaust back pressure simulation (see separate datasheet) can also be offered with this to give complete control of the airflow through the engine.

All systems are controlled by a single central CADET V14 control and datalogging system. This system is specially designed for engine and vehicle testing applications and as such has both software and software independent safety systems embedded. The CADET software and hardware offers control over dynamometer and throttle demand as well as all systems within the test cell. The CADET system offers true real time control and aligned data capture on over 1,000 physical and 2,000 calculated channels.

As will all Sierra CP systems, the designs are flexible and Sierra CP are able to modify any of the systems mentioned to cater for a customer's specific testing requirements, such as extended conditioning ranges, specific software modifications or specific datalogging requirements and channel counts.

BENEFITS AND FEATURES

- Flexible system design allows many test parameters to be changed and investigated
- Single source supply with turnkey project options
- All major parameters can be altered individually

APPLICATIONS

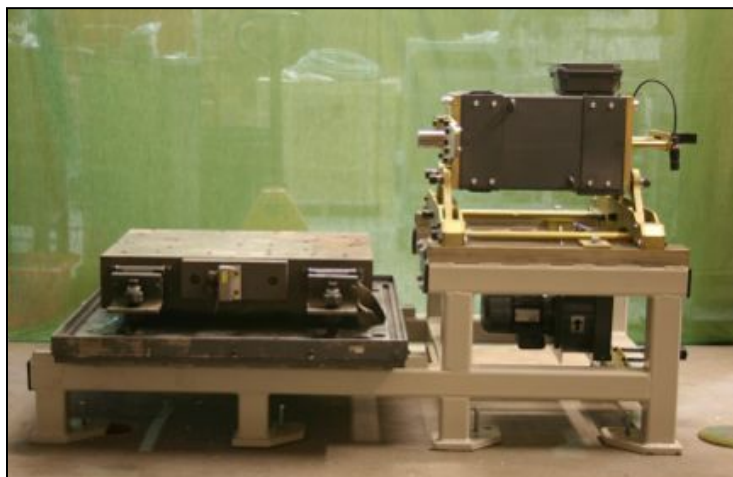
- Research and development
- Component testing
- Educational demonstrations
- Transient test cycles
- Emissions research
- Turbo/Super charger research

AC DYNAMOMETER AND INVERTER DRIVES

Sierra CP offer AC Dynamometers and regenerative drives are suitable for motoring and Absorption of the engine. When in Absorption mode the drive regenerates the electrical power back into the main electrical supply. This is deemed the most efficient method of absorbing the energy from the engine as heating does not occur.

Systems typically include the following:

- Swing Frame Air Cooled AC dynamometer with loadcell based torque measurement system
- Speed measurement
- Calibration arms and weight pans
- Common dynamometer and engine mounting frame



Sierra CP offer 3 standard single cylinder dynamometer setups of 45kW, 60kW or 75kW absorbing power, which are detailed in the table below. Sierra CP can offer custom dynamometer solutions to suit the specific engine testing needs such as increased power, torque or speed requirements.

Dynamometer	45kW	60kW	75kW
Speed	0 / 3300 / 6000 rpm	0 / 3200 / 6000 rpm	0 / 3200 / 6000 rpm
Power	0 / 45 / 45 kW	0 / 60 / 60 kW	0 / 75 / 75 kW
Torque	140 / 140 / 83 Nm	180 / 180 / 95 Nm	220 / 220 / 120 Nm
Accuracy	Speed < ±1rpm, Torque < ±0.25% of full scale		
Drive			
Overload Capability	110% for 30 seconds in 5 minutes		
Power Requirement	3ph, 120A, 380-415V	3ph, 160A, 380-415V	3ph 200A, 380-415V
Size H x W x D	2130 x 430 x 646mm	2130 x 430 x 646mm	2130 x 630 x 646mm

MOUNTING FRAMES

Sierra CP recommends that the engine is mounted on the same frame as the dynamometer. This aids alignment and transportation issues as well as reducing installation time. For single cylinder applications as an option an isolating seismic mass can be positioned under the engine, on the test frame.

Sierra CP can supply a dynamometer and engine mounting frame built to the required dimensions for the customer's specific engines. Tee slotted rail mounts will be attached for mounting the dynamometer and engine/seismic mass. A drive shaft guard will normally be supplied with the dynamometer and frame for safety.

CADET CONTROL AND DATALOGGING SYSTEMS

Sierra CP single cylinder test beds are usually supplied with a full CADET V14 control, automation and datalogging system. CADET V14 has been developed to create a single source integrated, flexible solution for engine test, research and development. When used in conjunction with other products from the Sierra CP range it provides an excellent basis for the specific needs of single cylinder engine testing and research.

The system can also be expanded to include the integration of emissions equipment, emissions analysis software or third party devices. Additional control of Sierra CP equipment can also be added such as ventilation systems or fuel systems without the need for PLCs.

The CADET system can be expanded as required to accommodate any of the following channel types:

- Analogue inputs: 0-10V, 0-20mA, 4-20mA
- Analogue outputs: 0-10V, 0-20mA, 4-20mA
- Digital inputs
- Digital outputs
- Thermocouples
- PRTs
- PTX pressure transducers with excitation
- Frequency inputs
- Frequency outputs
- CAN interfaces
- OBD interfaces
- Ethernet interfaces
- RS232, 422 or 485 interfaces

CADET V14 Software

CADET V14 is specifically designed for automotive test applications. The software is provided on a specially selected industrial, rack mountable system controller PC running Windows 7. The software offers the following features as standard for engine testing:

- Programming capability
- Bed protection using stage selectable high and low alarm and shutdown levels
- Automatic and manual control modes
- Data logging
- CP Trace V14, multiple y-axis, real-time display and analysis software
- Bumpless transfer between control modes
- Form based calibration mode
- Instrument Interfaces
- Speed, Torque and Direct/% control modes for Dyno and Throttle control

Further details on CADET V14's capability can be found in the CADET datasheet.

CADET Integrated Safety Features

Many safety features are built into the CADET hardware and the software to protect the test bed, dynamometer and the engine under test. The system does not simply use a 3rd party datalogging system with computer monitored protection, Sierra CP offer dedicated protection for key channels and systems on the test bed, with 8 computer independent shutdown channels.

Each CADET channel (physical or calculated) can be set with its own Low / High Alarm and Shutdown levels. These can either be default values or on a Stage by Stage basis. Typical safety channels include the following and others as required:

- Engine and dynamometer overspeed
- Oil pressure monitoring
- Oil temperature monitoring
- Coolant temperature monitoring
- Dynamometer supply services, water or electrical
- Dynamometer and drive temperature
- Exhaust and ventilation systems functioning
- System controller PC failure
- Emergency stop button
- Test cell door

Operator Interface

CADET V14 is designed for automatic, unattended and manual operation. The following equipment is the only interface required between the test system and the operator:

- CP 'winged keyboard'. This is a pre-formed, alloy tray supporting
 - 102-Key English (UK) keyboard
 - Encoders for dynamometer and throttle manual control set-points
 - Engine/ test bed emergency-stop 'mushroom' type push-button
 - Bed 'Alarm Accept', and 'Reset' push-buttons
- 2 off 19" flat screen colour displays
- PS2 mouse

Mechanical Throttle Actuator

The AT12 is an enclosed DC motor driven Throttle Actuator that offers fast response (120msec) and pull capabilities up to 150N. (Further details can be found in the AT12 Datasheet).

Alternatively CAN or analogue output throttle control options are available.



Engine Electrics Box

CADET Engine Test systems are generally supplied with Engine Electrics modules provides. These provide a marshalling point for the in-cell low voltage electrical systems. There are four relay

switched 12V/24V DC terminals, which switch from a common power source connection such as an in-cell power supply or battery. These can be switched on or off with the associated Digital Output during tests. They are typically linked to ECU, Fuel, Glowplugs and Ignition. These modules can either be supplied in an engine electrics box, or integrated into the datalogging transducer layout.

Datalogging

CADET is provided with channels for in cell safety, dynamometer control and control of any additional equipment supplied by Sierra CP. The CADET system will be provided with suitable channels for controlling all Sierra CP supplied equipment. For a typical single cylinder test system Sierra CP will provide the following datalogging channels available to the user:

- 7off K type thermocouple connections
- 2off PRT connections
- 10off analogue inputs channels (can be used for 4-20mA pressure transducers)
- 8off analogue output channels

Customer specific channel counts are available; please contact Sierra CP for further information.

Transducer Panels

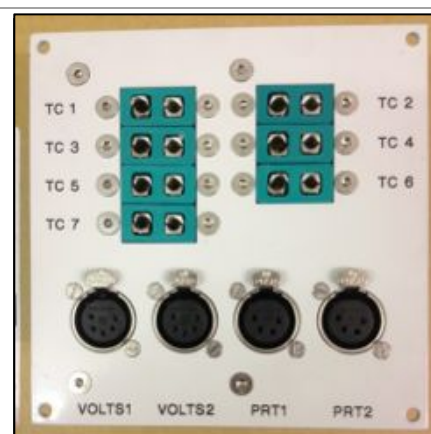
A layout will be provided in cell, which will accept the required data logging and engine electrics panels. Additional blank panels will be supplied to allow future expansion of the system. Panel sizes and looms are common across CADET systems allowing for panels to be swapped or upgraded with minimal effort. The panels supplied for a typical single cylinder test cell are shown to the right.

Cabinet

The CADET cabinet for a standard single cylinder system is a 19" 16U cabinet built onto castors (larger sizes are available for systems with higher channel counts). The cabinet houses Sierra CP i/o racks and the system controller PC.

The cabinet includes all the termination for the control, safety and data-logging sub-systems such as the Engine Protection Panel.

Any wiring associated with in-cell equipment is terminated into modules within the cabinet that provide a multi-way connection for onward connection using the supplied looms. The looms have multi-way connectors at each end, these are then connected to the corresponding connector in the cabinet the in-cell panels.



16 channel XLR Panel – 8 Analogue Inputs, 8 Analogue Outputs

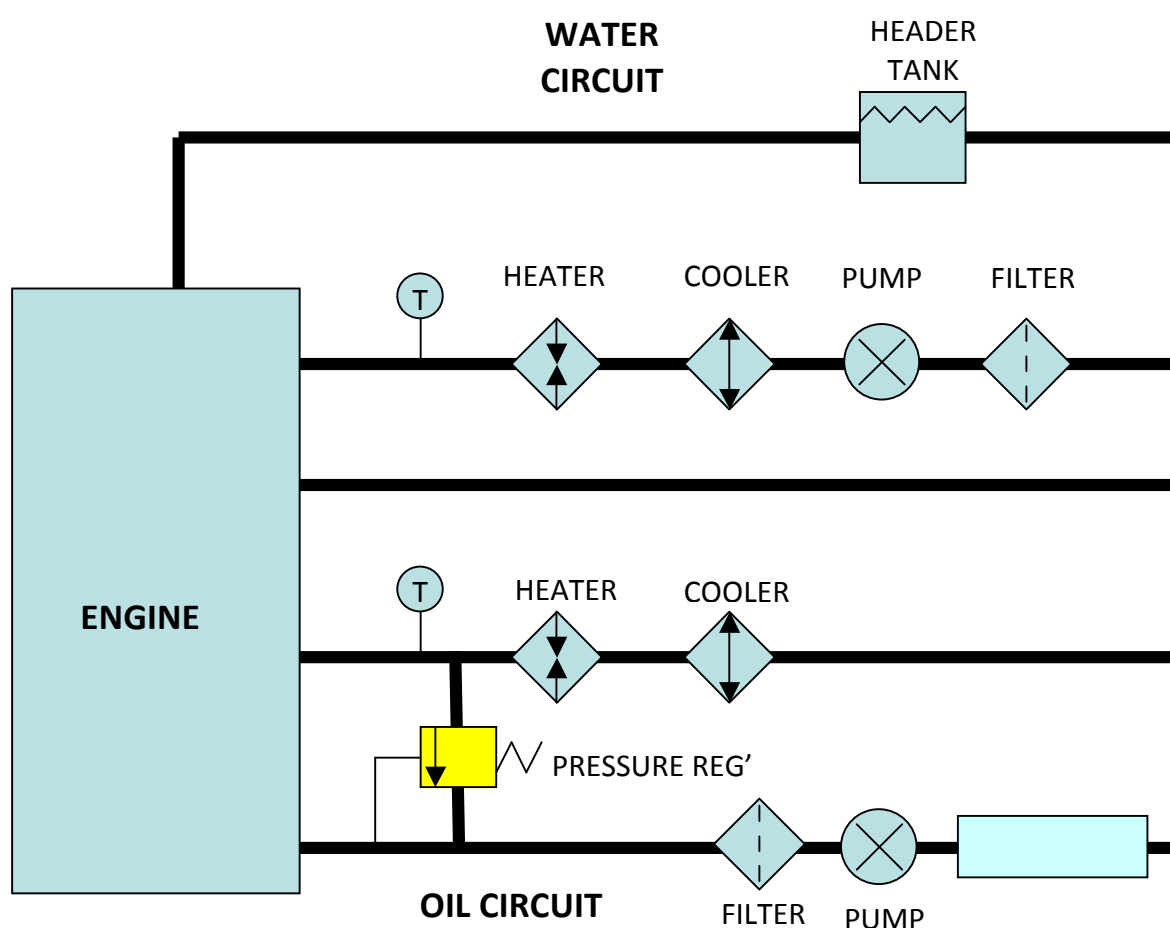
Mix Panel - 7off K type TC, 2off Analogue Inputs, 2off PRT Inputs

OIL AND COOLANT CONDITIONING

Typically single cylinder engines do not have oil or coolant conditioning and circulating abilities as standard, thus Sierra CP have developed an oil and coolant conditioning unit.

The cooling system allows the temperature of both coolant and oil to be conditioned by either heating or cooling the circulating fluids. Oil pressure control on the circuits supply lines can be included as an option. This is achieved by having a bleed valve installed in the supply pipework. These valves can either be manually settable or electro-pneumatically actuated to allow transient pressure variation.

Typically control temperatures of between 80°C and 100°C are possible, however as with all Sierra CP products, flexibility is inherent in the design to allow an amount of adaptation, should requirements change. The temperature is controlled using PID channels provided in the CADET system. The temperature of the oil and water/glycol can be set constant, or varied during a test as necessary. The system can also be used for conditioning of the engine prior to testing. The 'EVENTS' feature in CADET can be set to optimise the warm up time for the engine.



Standard Supply, for the conditioning units

- Heaters
- Heat exchanger for cooling modes
- Control box
- Flexible hoses to connect to the engine circuits
- Circulating pumps
- Sump, aeration tanks
- Level, pressure and temperature monitoring
- 3way control valve for cooling circuits

Typical Cooling system specifications

Oil	
Max Oil Flow Rate	5 l/min
Typical Oil Supply Pressure	4 bar gauge
Suggested Oil Delivery Temperature	80 - 100°C
Maximum Heat Rejection in Oil	5kW ($\Delta 28^{\circ}\text{C}$ at Max Flow)
Coolant	
Max Coolant Flow Rate	35 l/min
Typical Coolant Supply Pressure	1 bar gauge
Suggested Coolant Delivery Temperature	80 - 100°C
Maximum Heat Rejection in Coolant	35kW ($\Delta 14^{\circ}\text{C}$ at Max Flow)

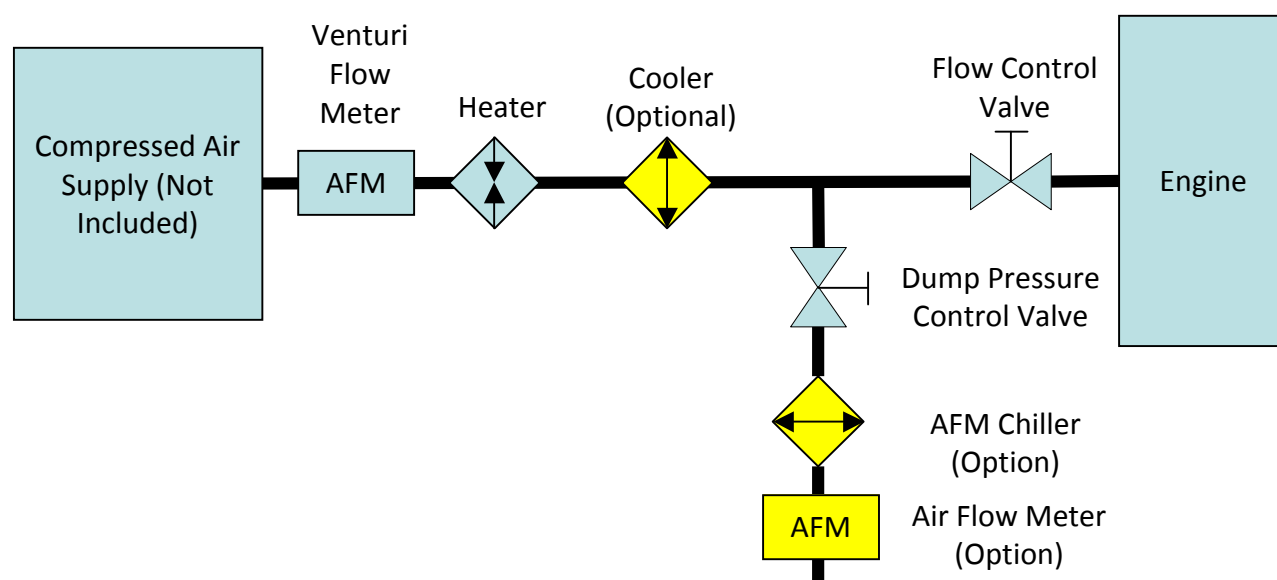
In order to allow cooling of the oil and the coolant a customer supplied bed water circuit is required. This should consist of a feed and return line complete with the pumps and filters as required. The connections should be provided to a location discussed with Sierra CP during the project phase.

HIGH PRESSURE BOOST RIG

Sierra CP are able to provide a boost rig that will allow dynamic control of pressure and steady state control of temperature of the engine supply air, to simulate turbo charger conditions. High pressure air is provided by a compressor unit (usually supplied by the customer). The boost rig conditions the temperature of this air by passing it through a fluid/air heat exchanger, whereby the fluid circuit has been suitably conditioned. Cooling of the air is also possible as an option. The pressure of the air is then reduced to the desired level, using a fast acting dump valve.

All of the air for the system is temperature conditioned; the air not used by the engine is dumped to the atmosphere. Fast acting valves on the dump and supply lines allow transient pressure regulation.

The TOTAL intake flow rate is measured on the rig intake using a venturi style flow meter. Engine Flow consumption can be achieved by putting an additional flow meter on the dump line (located at atmospheric pressure) and using a totalising calculation within the CADET system. This dump line meter is NOT included as standard. Optionally cooling heat exchanger can be installed in the dump line to provide a stable temperature for the dump line air mass meter.



An additional control rack with the required input and output cards will be installed on the rig, with a serial loop to the test cell CADET control and automation system controller. A dedicated tab in the operating system will be added that will allow control of the entire boost rig.

Standard Delivery Specification

Delivery Pressure	1.2 – 5 bar Absolute (Dependant on Compressor)
Pressure Control Accuracy (Assuming consumption remains constant)	±0.5% of Setpoint
Maximum Flow Rate	700 kg/hr*
Maximum Temperature	60°C
Minimum Temperature	Compressor Supply Temperature (Standard Unit) 6°C (Unit with Cooler and 1°C Chilled Loop)
Steady State Temperature Accuracy	±1°C

Customer responsibilities

The customer should provide the following in cell services required for the operation of the boost rig:

- High volume, compressed air supply (Sierra CP can quote on request)
 - Oil free air
 - At least 800kg/hr continuous air flow
 - 5.5+ bar absolute supply pressure
- Chilled supply with a 1°C supply temperature (if chilling capability is required)
- Dump line air meter (if required, Sierra CP can quote) and dump line ductwork
- Suitable flexible ductwork to the engine

OPTIONS

Sierra CP are also able to adapt standard equipment to meet any specific requirements. Please contact Sierra CP for further details. Sierra CP offer a wide range of test cell equipment and services which will complement the single cylinder test equipment. Further information can be found in the specific datasheets which are available on request.

Ventilation Systems

Sierra CP can supply bespoke ventilation systems for existing and new test cells. Ventilation systems can include heating and cooling coils, for test cell conditioning as well as test cell pressure regulation by using inverter driven fans. Recirculation systems are generally installed.

Fuel Measurement Systems

Sierra CP offer a range of fuel measurement units which use either gravimetric or transient fuel measurement techniques. All systems deliver fuel at ambient pressure and have capabilities for engine spillback.

Fuel Conditioning Units

Sierra CP have a number of products to condition the temperature and/or pressure of an engine fuel supply. All parts are stainless steel so a variety of fuels can be used.

Emissions Analysis Equipment

Sierra CP can provide emissions analysis equipment which interfaces to CADET V14. Sierra CP are able to offer TLS software which allows emissions regulatory test cycles to be run, analysed and reported.

Turnkey Solutions

Sierra CP specialise in bespoke and turnkey test cell installation if required.

Chiller Units and Blast Coolers

Sierra CP are able to supply a variety of chiller units and blast coolers to provide chilled water and bed water conditioned loops required for various equipment.

CUSTOMER RESPONSIBILITIES

Customer responsibilities are dependent on the equipment purchased, and will be discussed further during the project phase however in general the customer should be responsible for the following:

- Single phase power distribution
- Three phase power to the inverter drive and other equipment as necessary
- Instrument grade compressed air
- Test cell ventilation, heating and lighting
- Cable trays and trunking
- Civil work, as required
- High volume compressed air (Boost rig)

Innovate to Differentiate.



Vehicle Testing Systems

Chassis Dynamometers, CADET Control Upgrades,
Robot Vehicle Actuation

VEHICLE TESTING SYSTEMS

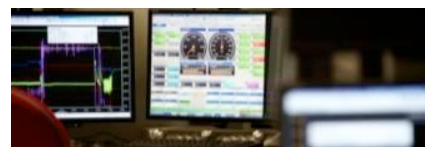
Since the mid-1990's, Sierra CP have been a global supplier of chassis dynamometer solutions for a wide variety of Vehicle Test applications. We can provide chassis dynamometers to suit most customer test cell specifications. Sierra CP are able to offer custom designed dynamometers to suit vehicles from motorbikes to trucks and tracked vehicles including combination test sets that accommodate a wide range of vehicle types in a single installation.

Sierra-CP provides solutions for a variety of test cell conditions ranging from climatic test cells with temperatures down to -40 degrees C to specialty NVH evaluation test cells with specific chassis dynamometer noise constraints.

We also offer a variety of drive options to suit customer testing specifications and budget requirements. These are supported by a range of standard products such as Robot Drivers and vehicle restraints. Our chassis dynamometer solutions are precision controlled by our advanced CADET V14 CDS control system which enables the total integration of the chassis dynamometer system with third party instruments such as Emissions Measurement & Analysis Systems. We also have the ability to be able to offer control system upgrades of existing Chassis dynamometers to offer precision control via CADET.



Innovate to Differentiate.



Chassis Dynamometers

Issue 4.1

INTRODUCTION

Sierra CP design and manufacture custom dynamometers for vehicles ranging from motorbikes and heavy duty equipment to tracked vehicles. As a global provider of custom systems flexible enough to meet a range of test specifications and budgets, we can provide chassis dynamometers to match most customer test cell installations. In addition to custom designs, a range of 'Standard' pre designed roller sets are available in a range of sizes please contact Sierra CP for further details.



Driven by our CADET V14 CDS (Chassis Dynamometer System), our chassis dynamometers cover all certification, research and development requirements for cars, trucks, motorcycles, three-wheelers, off-road vehicles, and treaded vehicles. We also offer cost-effective upgrades to existing test stands (from other manufacturers), with new CADET control and automation systems, thereby rejuvenating existing installations and prolonging useful operational life.

In addition, our range of Chassis Dynamometers has been extended to provide a cost-effective solution for testing motorcycles and scooters on a single roll set. We also offer a twin roller version for three-wheelers, quad-bikes and sub-compact city vehicles (see separate 'Motorcycle Chassis Dynamometer' datasheet). For specific high performance motorcycles, alternative dynamometer options are available upon request.

BENEFITS AND FEATURES

- High accuracy, fast response, repeatability, low maintenance
- Meet local standard requirements
- Inline & centre mount systems
- Twin and independent roll systems up to 4 axles
- Pre designed twin roller 'Product' available
- Custom designs available to meet specific requirements
- Powerful modular control and automation system
- Extensive range of support equipment and systems

APPLICATIONS

- Research & Development
- Certification
- Emissions
- Mileage Accumulation
- Climatic
- NVH
- EMC



SYSTEM DESCRIPTION

Pre Designed Roller Sets

Sierra CP have a range of pre designed roller sets which can be easily integrated into a test cell. 48 inch roller independent or twin roller systems are available, suitable for emissions or climatic testing. Multiple axles can be combined with wheel base adjustment to allow vehicles with more than one driven axle to be tested. All control is via a standard CADET V14 cabinet which will be configured for a number of operation modes.



Sierra CP have a standard packaged 750 mm twin roller product, which is shown above. This is suitable for testing cars and small industrial vehicles and is available with either AC or eddy current dynamometer options. Two rollers can be combined with wheel base adjustment to accommodate 4x4 vehicles. Optionally the unit can be specified for temperatures down to -40°C.

Sierra CP can supply multiple axle systems with sliding floor systems which allow safe wheelbase adjustment. For single axle units Sierra CP offer a number of wheel clamping solutions to clamp the non driven wheels in place for testing. These generally attach to T slotted rails mounted in the floor to allow for a range of wheel bases to be accommodated.

A single/double 450mm roller chassis dynamometer is also available for testing motorcycles, 3 wheeled vehicles or small 4 wheeled vehicles. Further details for these can be found in the 'Motorcycle Chassis Dynamometer' datasheet.

Fully Custom Solutions

Sierra CP specialise in custom solutions and thus allows us to design chassis dynamometers to meet whatever needs a customer may have. In the past Sierra CP have supplied custom designed dynamometer for the following applications:

- NVH with specific noise constraints
- Climatic emissions testing down to -40°C
- Large tracked vehicle testing
- Heavy duty multiple driven axle vehicles
- Hub mounted dynamometers
- Additional roller sets to existing dynamometer system
- Vehicle lifting systems





Sierra CP are used to providing custom solutions to fit existing site requirements, such as existing pit dimensions or building restrictions. Complete turnkey installation can be offered as necessary.

All chassis dynamometers are controlled by CADET V14 CDS, which offers precision and flexible control of your chassis dynamometer.

For further information please contact Sierra with your testing requirements.

Control System Upgrades

For the past 20 years Sierra CP have carried out control system upgrades on existing chassis dynamometers to allow CADET V14 to offer precision control over an existing system. This allows the entire obsolete control system to be removed, whilst maintaining the chassis dynamometer hardware. Sierra CP can then interface directly to the dynamometer and drive units to take complete control. In addition to this the CADET system offers inbuilt hardware protection, which will protect the rig in the event of failure. CADET has dedicated channels which allow cell services such as ventilation and E stop chains to interface with CADET.

Sierra CP have interfaced and replaced the control systems of a large number of dynamometers in the past including AVL, Froude, Horiba and Maha systems to name a few. Please contact Sierra CP with your chassis dynamometer specification for further information on the upgrade path. Further information on CADET V14 can be found in the appropriate datasheet.



OPTIONS

Sierra CP offers a range of integrated System components and products to support the complete operation of a Chassis dynamometer Facility.

- TLS – facility management & emissions reporting software
- Drivers Aid
- Robot Driver
- Pedal actuators
- Auto Fuelling / Measurement system
- Headwind fans to simulate air speeds
- Wind tunnels
- Particulate emissions measurement equipment
- Climatic or NVH test cell fit out
- Road shells
- Tyre burst detection

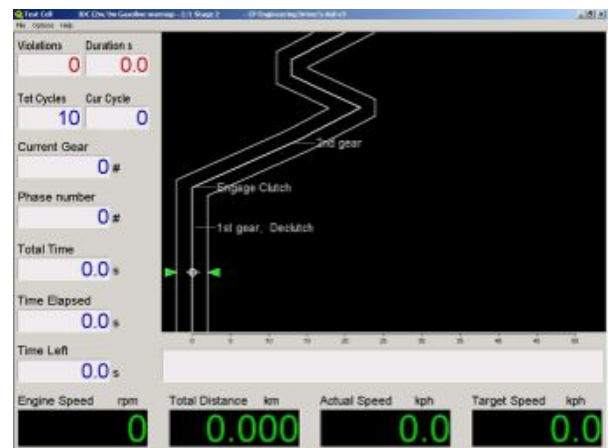
Further details can be found in the relevant datasheets, or are available on request.



CUSTOMER RESPONSIBILITIES

Generally the customer should be responsible for the following:

- 3 phase electrical power (for AC machines)
- Cooling water (for Eddy Current machines, or AC water cooled dynamometers)
- Pit construction (Sierra CP will provide drawings as required)
- Fire suppression system
- Test cell structure, lighting and heating



Sierra CP can quote for offering these facilities and services if necessary. Please contact Sierra CP for further information.

Innovate to Differentiate.

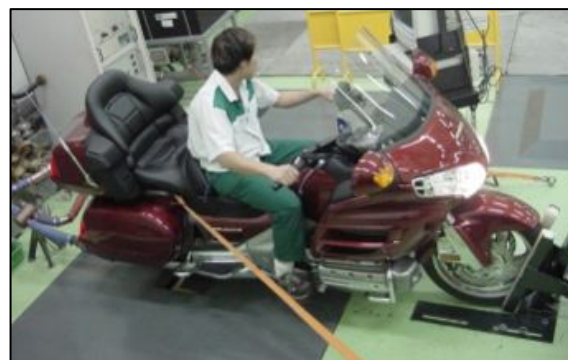


Motorcycle Chassis Dynamometer

Issue 4.1

INTRODUCTION

Sierra CP have developed a range of Modular Chassis Dynamometers, controlled by CADET V14 CDS software, which have been designed and developed to provide a cost effective solutions for the testing of motorcycles & scooters on the single roll set and three-wheeler, Quad bike and sub compact city type vehicles on the twin roller version. For Specific High performance motorcycles alternative dynamometer options are available.



SPECIFICATION

Maximum Test Speed		200 km/h
Maximum Tractive /Braking Force 0 – 84 km/h		2,100 N
Max Power 84 – 200 km/h		60 kW
Base Inertia – Approximate		140 kg – Single Roller 240 kg – Twin Roller
Mass Simulation - Approximate		100 – 450kg – Single Roller 100 – 850kg – Twin Roller
Roller diameter		600 mm
Tolerance on diameter		±0,1 mm
Roller – Width		450mm
Twin Roller Track Width		850 – 1750mm

These specifications are for the standard design. Custom designs are also available to meet specific customer requirements.

BENEFITS AND FEATURES

- Automatic compensation of bearing losses
- Reduced Installation and Commissioning Program with minimal maintenance requirements
- Compact design of the Centre Machine reduces the Pit / foundation requirements
- AC Drive & Motor technology –providing fast response and extended inertia Simulation
- Cost effective System solution
- Future Proof Dynamometer and Control System with CADET upgrades

APPLICATIONS

This Range of Chassis Dynamometers is suitable for the types of testing indicated below:

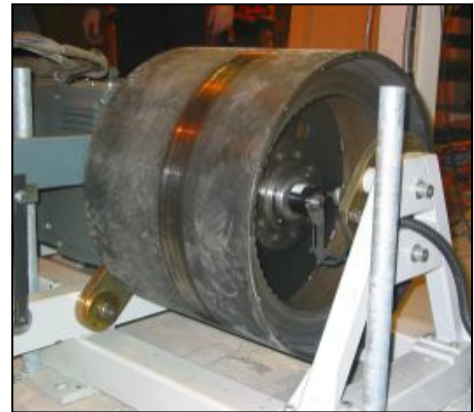
- Emissions
- Durability
- Performance Testing
- Quality audit

SYSTEM DESCRIPTION

Rollers

The roller/s are manufactured as a steel fabrication and are capable of supporting the axle loads detailed. The roller mass is designed to provide the base inertia of the dynamometer; after stress relieving it is machined and balanced.

A pneumatically actuated brake is incorporated into the system and acts upon the stiffening webbing of the roller. This is designed for use as a parking brake only. A pressure switch and control valve are included; both mounted on the machine base frame.



Speed is measured using a precision incremental encoder, directly connected to the AC motor/roller shaft end and provides an accurate output of roller speed.

Reacted torque is measured with a load cell, connected between the dynamometer base frame and the AC motor carcass. As forces are applied to the roller surface the reaction through the motor carcass is measured by the load cell.

AC Motor

The chassis dynamometer utilises an AC motor as the motor/absorber unit and is capable of working in both directions and simulating test vehicle inertias electrically. The motor is air-cooled using a fan mounted off the base frame. The AC motor is supported on torque reaction arms to allow free rotation of the motor carcass, with torque being measured by a load cell. The torque reaction arms are directly supported from the base frame.

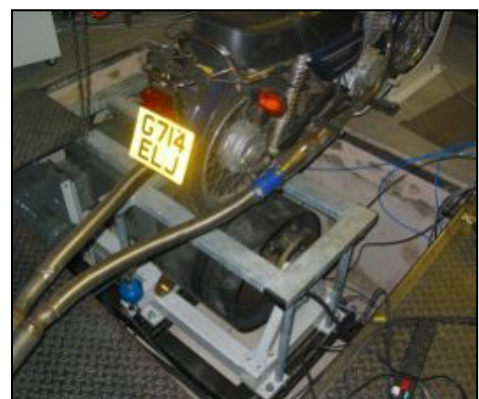


All base frames are of a welded construction using hollow steel sections with machined pads to accept the motor/roller sub assembly. Features are included to mount the brake and roller encoder.

The base frame incorporates suitable lifting eyes and pads/feet to allow it to be bolted to concrete plinths.

Floor Plates

Steel floor plates and supporting beams can be provided to maintain a level floor around the roller surface and are to be supported from the pit edge trimming. Sierra CP will provide drawing details of required Pit Edge Trim. Alternatively a complete, raised assembly, including floor plates can be provided to minimise required installation.



CADET V14 Chassis Dynamometer Control System

The CADET system will be supplied with the following major assemblies:

- **Control Cabinet** 25U, 19" cabinet housing the control hardware and system controller
- **Operator Interface** Monitors and Winged Keyboard, providing a display of all data and manual control
- **In-Cell Equipment** providing the system interfaces with the chassis dynamometer and vehicle

Software

Typically the following software will be installed on the system controller.

- Microsoft Windows 7 operating system software
- Microsoft Visual Basic
- CP CADET V14 CDS Vehicle Test System software with:
 - Programming capability
 - Programmable bed protection
 - Automatic and Manual Control modes
 - Data logging
 - CP Trace V14, multiple y-axis, real-time display and analysis software
 - Bumpless transfer between Auto and Manual control
 - Form based Calibration Mode
 - Low and High Alarm and Shutdown levels



Further details on CADET V14 can be found in separate datasheets.

Motorcycle Wheel Clamp

The Motorcycle wheel clamp enables an efficient positive location of the front motorcycle wheel and also acts as a fast method of referencing the rear wheel on to the apex of the Chassis Dynamometer roll set for repeat tests

- The wheel clamp device is suitable for most scooter /Motor cycle wheel profiles (See chart below)
- In event of power loss, wheel clamp will stay locked.



	Min.	Max.
Wheel Width	63mm	140mm
Wheel Diameter	350mm	700mm

Wheel clamping devices to suit specific ranges of motorcycles can be offered on request

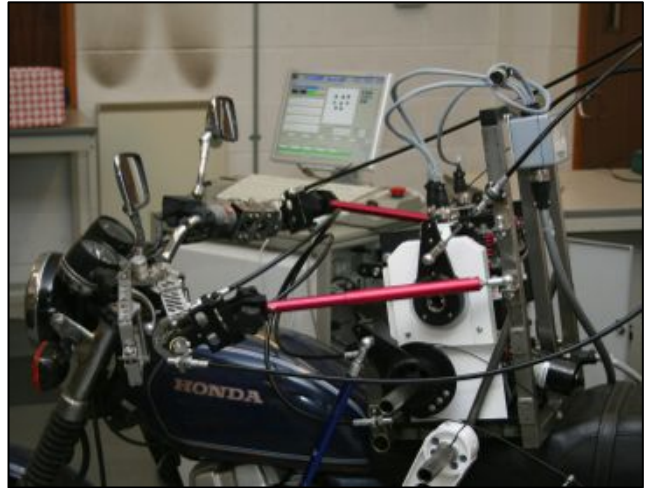
OPTIONS

Sierra CP offers a range of integrated System components and products to support the complete operation of a Chassis dynamometer Facility.

- TLS – facility management & emissions reporting software
- Drivers Aid
- Robot Driver
- Hand Grip Throttle Actuator
- Auto Fuelling / Measurement system
- Headwind fans to simulate air speeds

Further details can be found in the relevant datasheets, or are available on request.

CUSTOMER RESPONSIBILITIES



Generally the customer should make available or prepare the following services:

- Electrical 3 phase Power Supply
- Compressed Air
- Pit Drainage
- Ductwork
- Foundations / Pit works (drawing supplied by Sierra CP)
- Pit Edge Trimmings (drawing supplied by CP)
- Fire suppression systems
- Fire/ vapour detection

These will be confirmed and discussed further during the project phase.

Innovate to Differentiate.



Vehicle Robot

Vehicle Automation for Emissions and Endurance

Issue 4.1

INTRODUCTION

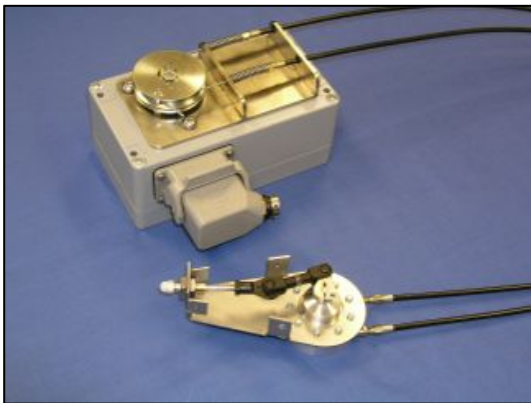
The Sierra CP Vehicle Robot is designed for stand-alone or integrated actuation of a vehicle under test on a chassis dynamometer. The robot consists of a pedal module, gear shift module and control module.

The pedal module consists of up to three DC rotary pedal actuators which can be easily installed in the foot well of a vehicle under test. Clamps are supplied to attach to the pedals, with a variable length strut connecting between the actuator and clamp.



The torso module allows left/right and forward/backward actuation of the gear lever via two DC actuated 'Arms', which can be installed in either the driver or passenger seat. A light weight gear cap attaches to the gear lever, which then attaches to the actuator arms via variable length struts. Integrated clutches in the arms decouple when in gear, to minimize the force on the gearbox and transmission. Looms from the two actuation modules then connect to the control module (which can either be in-cell or control room based) which provides actuation and control, powered by the CADET V14 robot control software and hardware.

Once installed the robot is 'taught' the gear positions by an operator manually selecting a gear and then pressing an 'Acknowledge' button. The gear positions relative to each other and the actuator current position can be viewed in the CADET Robot tab. The clutch and brake bite points are then



manually taught by the press of a single button on the pedal module. CADET automatically maps the throttle with the engine running. An engine speed signal is required by CADET (Either from a customer sensor, control system or OBD/CAN interface, see options section).

An additional module for ignition actuation can also be supplied. This is suitable for both key and push button style ignitions. This is based on a push/pull cable system, driven by a remote DC rotary actuator. A

number of easily interchangeable attachments are supplied which either allow the actuator to mount to a key, or actuate push button ignitions via a lever arm (a short arm is shown, a long arm attachment is also supplied).

SPECIFICATION

Robot Specification	Units	Value
Operating Temperature	°C	-10 to +50*
Gear Actuation Module		
Maximum Shift Force (Clutch Protected)	N	60 with 350 mm arms (Shorter arms are available for increased force)
Maximum Gear Travel	mm	250 (in X or Y)
Typical Gear Shift Time	ms	440
Gear Module Weight	kg	19 (can also be split into 9kg and 10kg modules)
Pedal Actuation Module		
Maximum Pedal Force	N	250
Maximum Pedal Travel	mm	250
Typical Shift Time	ms	350 (Clutch and Brake) 250 (Throttle)
Module Weight	kg	3 Per Pedal
Ignition Actuation - Option		
Maximum Rotation (key)	Deg	210
Maximum Torque (key)	Nm	7.5
Maximum Actuator Push Force (push button)	N	150 (actual force can be limited)

*Lower temperature variant down to -40°C is available as an option

BENEFITS AND FEATURES

- Flexible channel assignment to different controls, as project requires
- Modular construction allows easy installation
- Gear actuation of both left and right handed vehicles
- Up to six different actuation channels
- Non-intrusive design
- Designed to mimic human behaviour
- Integrated gear shift actuator clutches minimise gear lever force when in gear
- Cost effective solution
- Movable between test cells

APPLICATIONS

- Emissions Work
- Endurance Testing
- Mileage Accumulation
- Research and Development
- Climatic Testing

SYSTEM DESCRIPTION

The Vehicle Robot is made up of the following sub-assemblies:

- Torso shift module. X-axis gear shift position
- Torso select module. Y-axis gear select position
- Pedal Box
 - Throttle
 - Clutch – optional
 - Brake – optional
- Ignition actuation module – optional
- 12U 19" Control Cabinet
 - Electronic Control Unit. Power supplies and control hardware for module actuation
 - CADET V14 control, monitoring and automation system
 - System controller PC (can also be supplied loose for separate control room installation)



All the DC actuators are powered by electronic control units which are built into the control cabinet. This is to minimise the weight of the robot. Positional feedback signals from the actuators are provided to CADET to allow closed loop control.

To minimise gearbox wear and to assist in gear training, magnetic clutches are used to de-couple the gearshift arms from the drive actuators. By employing this method, minimum wear on the selector forks and hubs within the gearbox is achieved. The software only engages the magnetic clutches when a gearshift is taking place to ensure that the forces acting on the gearshift during normal operation may be ignored. A further benefit of the clutches is their guaranteed maximum force transfer protects the transmission in fault conditions.

As an option the design can be adapted for the inclusion of force sensing at the gear lever and pedals by the inclusion of in-line load cells in the actuator struts. The electrical current of each actuator is measured by CADET, which can give an approximate value for the actuation forces required.

Pedal Box



The pedal box module provides up to three actuation struts for clutch, throttle and brake. The struts are expandable in steps of 25 mm using press release keys and are fitted with ball joints at each end. A clamp bracket with integral ball end is fixed to the pedal to allow the strut to be clicked into place. The pedal box module is fixed to the vehicle by brackets clamped to the seat sub-frame. Alternatively, fixtures can be provided to allow both the torso and pedal modules to be installed on the driver's seat. A number of LED displays on the unit indicate the state of the drive and

clutch control signals. The force of the actuators can be limited by restricting the current supplied to the actuator, which is proportional to the force.

Torso Module

The Torso module is split into two sections that are locked together in use. These contain the Shift (left-right X-axis) and the Select (front-back Y-axis) modules. One person may split the torso to enable lighter installation of the robot.

The Torso gear selector module has been designed around the general envelope of a human driver to allow it to be used in the majority of vehicles. It is restrained in the vehicle by the use of a number of straps which attach around the rear of the seat.



Adjustment of the X-axis shift actuator mechanism relative to the seat is provided to allow the maximum length of strut adjusted. Overall positioning may use the vehicle seat adjustment while actuation struts, with low friction ball joints, are expandable in steps of 25 mm using press release keys.

The Y-axis shift module gear change arm may be mounted on either end of the actuator shaft. This allows rapid set-up for either right-hand or left-hand drive vehicles. It is possible to convert from left-hand drive to right-hand drive configuration in less than two minutes. The torso module can be installed either on the driver or passenger seat.

Robot Operation

The strategy used by the Vehicle Robot during gearshifts is set within the program but it is fully configurable. This allows the optimum settings of change times and forces to be determined and stored along with calibration data for the Chassis dynamometer rolls and engine speed. A full safety and automatic gear map may also be stored. Gear ratios are stored to assist in detecting a miss-shift. These ratios may be determined from a technical manual or by operating the vehicle manually on the rolls. Once these settings have been stored they may be re-called when the system is ready for use, once training has been carried out.

The Vehicle Robot is trained in a number of simple steps to perform gearshifts. This is achieved by the use of a notebook, connected when required locally, allowing its use inside the vehicle. Each gear and the neutral position are manually selected and each then logged by a single keystroke on the notebook. The X-Y positions of the centre point of each gear position are therefore taught to the system. This process is very simple and fast making it possible to quickly re-train the system if the position of the Vehicle Robot is changed. It is generally necessary to carry out this training on each occasion that the Vehicle Robot is installed in a vehicle.

The pedal actuators are connected to the vehicle pedals by the drive rods. The drive rods are adjusted such that at 0% actuator travel represents 0% pedal travel. Once set the robot will find the maximum travel of the Clutch, Brake and Throttle by monitoring the current levels in the motors to determine the extent of travel. This position is then saved as the 100% value. The robot is also able to determine the 'bite' point of the clutch and this corrects itself during operation as the clutch wears.

The throttle is automatically mapped to determine the required throttle positions during the gear changes. This is achieved under the control of the software with the engine running. A signal is required which represents the engine RPM. Both the clutch, and the brake bite-points are taught to the system by the press of a single key as it is determined manually.

Test Cycles

Sierra CP have a large library of test cycles such as FTP, Euro and Japanese, already programmed and ready to run on the robot test bed. The full set will be supplied but if the cycles required are not available Sierra CP can program these for the customer. This would normally be chargeable, further details available on request. Alternatively the customer can write and edit these and new test cycles. Training will be given in this area during the commissioning of the robot system.

The test schedule data is written onto the CADET V14 system controller. This is used to drive the test. The chassis dynamometer should provide realistic resistance to the vehicle according to road load model and road speed. The Sierra CP robot is set into a pre-test mode and the actual start of the test is signalled by a digital output from the host controller to the CADET system. Different drive cycles are selected from a test file directory on the Robot Control PC. An Emergency Stop is on the control keyboard. It is possible to link in-cell Emergency Stop buttons or other external shut downs signals to the Robot Control system.

OPTIONS

The Sierra CP vehicle robot can be supplied with the necessary actuation channels required by the customer. A number of options for the robot system are available, for example:

- OBD-II interface for engine speed and other valves
- CAN interface for engine speed (Customer should provide CAN files to Sierra CP)
- Datalogging
- Interface to emissions equipment
- Emissions regulatory calculations (see TLS datasheet)
- Custom gear shift modules (such as paddle or column shift)
- UPS systems for failsafe shutdown in the event of power failure
- Motorcycle and 2/3 wheeler robot (see separate datasheet)

Sierra CP can also offer CADET chassis dynamometer control systems to retro fit existing systems as well as supplying complete Chassis dynamometer solutions up to 8x8. Further details are available in a separate datasheet.

CUSTOMER RESPONSIBILITIES

Generally the customer should make available or prepare the following services:

- Single phase electrical power supply
- Engine and roller/vehicle speed signals
- Chassis Dynamometer, or Test Rig, operating in a road load mode
- Digital input from control system to signal the start/end of tests

Innovate to Differentiate.



Emissions Particulate Measurement Equipment

Filter Based and Real Time Particulate Measurement
to Meet Emissions Regulation Certification

EMISSIONS PARTICULATE MEASUREMENT EQUIPMENT

Our mission is to be your engine particulate emissions specialist. We give our customers throughout the world a complete engine PM emissions sampling solution using our flagship BG3 as the hub of this effort.

Our goal is to develop world-class Particulate Flow Dilution (PFD) systems that provide the highest quality sample data, greatly increase testing efficiency, drastically reduce costs, and improve test-cell safety. Sierra CP has a great track record. Throughout the 1990's, Sierra's BG®1 and BG®2 became the leading PFD in the world. We now support hundreds of BG systems used by customers located all over the world.

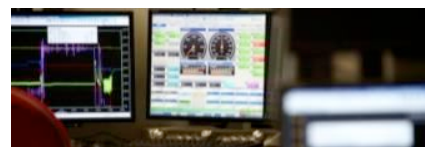
Sierra CP has forged a unique partnership with Caterpillar. Together, engineers worked as a team to develop, design, and test the BG3 to meet the stringent needs of engine manufacturers through cutting-edge technology and patented inventions. These partnerships have allowed Sierra CP to design the most innovative and state-of-the-art PM product offering on the market. Sierra CP owns the exclusive worldwide license to Caterpillar's patented micro-dilution tunnel technology Patent #5,058,440 and system flow control features described in United States patent #6,615,677 along with eleven additional US patents used in the BG3

Our goal is to offer customers throughout the world a single choice for their particulate measurement needs, offering solutions from sample collection to final processing for customers using the gravimetric method currently written in the regulations. Our team is set up to rapidly provide any customer with standard or custom solutions.

We manufacture a wide variety of emissions measurement solutions to meet nearly any engine and vehicle testing application. We specialize in particulate matter (PM) partial flow dilution sampling with our market leading BG3 technology. In addition, our real-time diesel soot mass and average soot agglomerate size/number/surface area measurement system is a best-in-class instrument for this difficult application. We offer seamless integration and control of devices such as CVS and gaseous via our flagship CADET V14 Test Automation software. It is our belief that this gives our customers the flexibility to choose from the many different emissions instruments, while still benefiting from our user-friendly CADET V14 interface and test cell control.



Innovate to Differentiate.



BG3

Partial Flow Dilution Particulate Sampling System

Issue 4.1

INTRODUCTION

In use since 2004, BG3 Partial Flow Dilution (PFD) technology effectively performs engine research and development to accurately sample exhaust PM (Particulate Matter) emissions over both steady state and transient test cycles. On January 7, 2011, PFD was signed into law and is now included in the United States Federal Register as a legally recognized alternative method to CVS in 40 CFR part 1065 for engine certification. The Direct Final Rule (DFR) contains, among other things, the unprecedented allowance to use PFD for engine emissions PM transient certification testing.



In 2013, a high performance version was introduced as a next generation PFD system called, BG3 Elite (Pictured Left). The Elite has all the same specifications as its predecessor the BG3, but is refined for applications requiring 47mm filter media such as Part 1065, and combines smaller, more precise flow control valves and flow measurement components with an upgraded pressure transducer suite to build on its industry-leading technology base. The Elite is available in a 65 slpm version and a 100 slpm version to cover a broad range of PM sampling needs. Sierra-CP's proprietary Cadet V14 software is being introduced on the Elite product, along with a patented feature that actively controls diluted sample to an off-board measurement device while simultaneously maintaining Part 1065-required metrics for proportionality and filter face velocity required for gravimetric sampling.

The BG3 system is a highly flexible engine PM emissions sampling device protected by thirteen patents. BG3 is the recognized standard in the industry for PFD sampling. BG3 is the most widely

used technology of its kind and boasts an installed base of more than 300 units globally.

BG3 is used for proportional sampling on transient test cycles with any fuel (diesel, gasoline, natural gas, etc.) and can be used on engines of any size in both engine and chassis test cells. BG3 is also equally effective for steady-state test cycle PM measurements. Steady-state sampling times range from two to five minutes depending on the relative particulate emissions output of the engine and the size of the filter holder used. Test cycles for any regulation can be easily designated, set up, and run. BG3 satisfies all ISO 8178, ISO 16183 and 40CFR 1065 requirements for transient and steady-state equivalency, as well as EPA requirements for non-road steady-state (CFR Part 89), supplemental 13-mode and ramp modal cycle testing. The system can also be used as a diluter for particle sizing instrumentation and for gaseous emissions measurement systems, while simultaneously and accurately sampling particulate matter.

BG3 United States EPA Approval (January 2011)

BG3 PFD technology has been in use since 2004 effectively performing engine research and development to accurately sample exhaust particulate matter emissions over both steady state and transient test cycles. On January 7, 2011, PFD was signed into law and is now included in the United States Federal Register as a legally recognized alternative method to CVS in 40 CFR part 1065 for engine certification. The Direct Final Rule (DFR) contains, among other things, the unprecedented allowance to use PFD for engine emissions particulate matter transient certification testing.

The Docket for the DFR shows that the basis for the US EPA decision was the correlation to FTP and NRTC CVS transient test cycle PM (particulate matter) demonstrated by Sierra-CP's BG3, as required by 40 CFR Part 1065.12. A 5-year program conducted in cooperation with the US EPA resulted in a BG3 vs CVS multiple engine, two-lab correlation study requiring the measurement of PM over a two-decade range in concentration levels. It was successfully performed to prove BG3 complies as a suitable, fully compliant alternative method to CVS for certification of engines tested on 2007 and Tier IV transient test cycles. This historical milestone opens the door to greater PM testing flexibility for all Heavy Duty (HD) as well as the Light Duty engine manufacturers requiring compliance to 40CFR Part 1065 test procedures. For more information on the BG3 EPA approval, please visit: www.sierrainstruments.com/autotest/products/emissions-analytical/bg3_epa_approval

BENEFITS AND FEATURES

- Compliant to US EPA 40 CFR Part 1065
- Protected by thirteen US Patents
- Documented gravimetric correlation to CVS
- Any size/type engine, any fuel
- Outstanding transient sampling fidelity
- Supports light-duty bag sampling and Euro6 PN
- Optional real-time solid particle mass, number, size
- Interface Exhaust-Trak raw exhaust mass meter
- Satisfies ISO 8178 & 16183, 40 CFR Part 89, Euro 3, 4, 5 & 6
- Approximately 1/10th of HD CVS system cost of ownership
- Approximately 1/100th to 1/1000th the annual energy usage of HD CVS
- Patented PFD (Partial Flow Dilution) tunnel has ultra-low particulate loss and requires no cleaning with proper operation
- Integrity of internal flow systems, proprietary daily mirror calibration method
- Yields excellent accuracy and repeatability over a wide range of dilution ratios
- Portable from cell to cell to maximize flexibility and ROI
- Ability to accurately measure PM either pre and post catalyst and/or DPF for research or DF testing
- Filter Size: 47 or 70mm standard
- Sample Flow Accuracy: Less than +/- 3% at dilution ratios of 15:1 or below
- System working standard flow measurement accuracy: Less than 1% of reading
- QC Sample flow check meter flow accuracy (optional): <3% of reading at 20-50%FS,
- <2% of reading at 50-100% FS.
- Sampling Time: A nominal sampling time of 2 to 5 minutes per mode is recommended for single filter/ mode testing on a 0.1g/hp/hr 8- mode cycle-weighted emissions engine when using 70mm test filters.
- Input Power: 110 or 220 VAC, 50/60 Hz (Indicate at time of order)

- Dilution Air Supply: 90 PSI, 3.5 CFM (6.2 bar, 6 m³/hr)
- Internal Sample Update Rate: 80Hz

APPLICATIONS

- Transient and steady state engine and vehicle testing
- Designed for diesel, gasoline or natural gas engines of any size
- Can be used in engine or chassis test cells

SYSTEM DESCRIPTION

Technical Description

The fundamental description of BG3, per ISO8178-1 (5) is as a “partial flow dilution system with flow control and total sampling”, otherwise known as a ‘split, then dilute’ methodology. The operational difference between BG3 and CVS is that a CVS first dilutes the full flow of raw exhaust and then collects PM from a small fraction of that flow (dilute, then split), while the BG3 first proportionally extracts and then dilutes a small fraction of the raw exhaust and then collects PM on a gravimetric filter from that flow (split, then dilute). The BG3 design premise is to provide equivalent results to CVS by maintaining proportionality of the raw exhaust sample mass flow relative to the exhaust mass flow rate of the engine.

The primary purpose of BG3 is to control the flow rate of a representative sample of exhaust during an engine test cycle where engine speed, load, airflow and fuel flow values exhibit high rates of change over very short time frames. The magnitude of engine inlet air mass flow excursions can approach 10:1 within less than two seconds. The challenge for any PFD technology is to maintain constant proportional flow from an exhaust stream with a highly variable mass flow rate throughout a typical test cycle. In order to ensure that the total mass of particulate trapped at the filter is equivalent to that obtained by the use of a full flow CVS, the sample flow rate must be controlled in real-time to be proportional to the exhaust mass flow. Further, it is necessary to control this sample flow rate to ensure that the filter temperature does not exceed the regulatory defined limit while the dilution air temperature is maintained in the range required by the regulations.

Near Zero-Loss Dilution Tunnel: The magic of BG3 technology is the patented dilution tunnel which eliminates the major Achilles heel of any PFD, the deposition of particulate on dilution chamber walls as the diluted exhaust sample is transferred to the filter from the raw exhaust stream. Ultra low particulate loss in the patented radial inflow partial flow dilution tunnel (Pictured) and a very short equilibration zone before the filter set the BG apart from all other PFSS. Sierra’s patented dilution tunnel technology is a chamber under pressure. Conditioned dilution air permeates from the outside of the chamber in through the walls of a sintered metal tube carrying the diluted sample, creating a hydrocarbon-free air barrier. This eliminates the effect of the dilution system’s “history” on the test sample.



BG3 is an integrated product that incorporates two flow devices supplying and extracting gas used in the dilution tunnel design. The mass flow of raw exhaust sampled at the probe is the difference between the flow rates of the dilution and total mass flow meters. This sample flow is calculated as the difference between the total and dilute flow.

Data Quality Assurance

- 1) Patented Transient Dilution Airflow Control: Allows the speed of the dilute mass flow controller to correctly correlate the sample flow with the actual engine exhaust mass flow.
- 2) Sample Flow Rate Confirmation: A third mass flow meter confirms the sample flow rate by comparing the measured flow to the set flow of the BG3. This serves as a Go/No Go sample flow check before each test. Third mass flow meter shown inside the Model BG3
- 3) Validation. The Model BG3 continuously controls and validates all critical operational and calibration data parameters and readings during each test. Engineers can make decisions during and after a test.
- 4) Calibration
 - Fully automated daily calibration between each test.
 - Fully automated leak check
 - Filter face velocity (sample mass flow rate) for filter size

Software/User Interface

Based on our flagship CADET Automation Software platform, the BG3 control software is a user friendly application that allows the engineer to work independently of a host system or interfaced with a host. The BG3 software allows the knowledgeable engineer the diversity of testing any size of fuelled engine for particulates, as well as perform calibration and troubleshooting. The user can collect PM samples during test programs and allow remote control of the BG3 by a host PC. The BG3 system and software is designed to allow novice users to easily collect accurate particulate samples, however it is recommended that users should have:

- Some experience in the operation of engine emissions measurement systems
- Engine test stand and/or chassis test cell experience
- A basic understanding of Microsoft Windows based computers and text processing

Main Status Screen: The status screen displays the system layout and all of the real-time parameters before and throughout the test. The operations display is a useful tool for the operator as the test is being performed and after completion.

Calibration Screen: The "Tracker" function is a tool that every engineer will find irreplaceable. This screen can be used by the engineer to track any of the functions (diluted mass flow, delta pressure, engine exhaust flow versus sample mass flow) or other immediate test functions for immediate reference to archival data.



Tracker Screen: The engineer will find the calibration of the system very manageable and efficient. The fully automated calibration routine can be performed at any time.

OPTIONS

Sierra CP can offer a range of options with the BG3 including:

- SootTrak – Laser based real time particle measurement system (See separate datasheet)
- HeatPak – Filter paper temperature conditioning
- Weigh booths
- AirTrak – Intake air measurement (see datasheet in “In Cell Equipment” section)
- ExhaustTrak – Raw exhaust mass flow measurement (see datasheet in “In Cell Equipment” section)
- Filter multi changer units – enabling multiple samples to be taken during a single test

These can be found in the ‘BG3 Support Equipment’ datasheet.

CUSTOMER RESPONSIBILITIES

Sierra works closely with each customer before, during, and after the installation and commissioning of the BG3, ensuring a smooth system launch and ongoing customer satisfaction.

Installation

- An on-site Sierra engineer performs all commissioning and training services to achieve high customer satisfaction
- Since the BG3 is portable, it is set up quickly in any configuration of engine and test cell environment
- During commissioning, the Sierra engineer calibrates the BG3 with certified calibration equipment
- Sierra sends a specification sheet to pre-empt future questions or problems

Facility Requirements

- Input power of 230/110 VAC, 20 amp (2 each), 50/60 Hz
- Clean supply of dry air at 80 psi minimum to 100 psi maximum - Sierra assists each customer so that shop air is optimal for BG3 operation
- The BG3 is located within the test cell - The space required to accommodate the cabinet is 24 inches W x 36 inches D x 72 inches H
- The BG3 has a 19 inch rack mount PC and a 17 inch plasma screen monitor that can be remotely placed in the control room of the test-cell

Four Step Sample Collection

- Step 1: Load the Filters. Insert the sample filter pair into the filter holder or load the filter Multi-Changer cassette.
- Step 2: Set-up the Test. Enter the appropriate flow sample parameters into the test set-up screen.

- Step 3: Collect the Sample. Press the standby button, the BG3 automatically collects the sample.
- Step 4: Sample Complete. Remove filter pairs for PM mass measurement. A filter weight calculation sheet is available for the engineer's convenience.

Innovate to Differentiate.



SootTrak

Laser Based Real Time Emissions Particulate Sampling

Issue 4.1

INTRODUCTION

Sierra CP's SootTrak™ laser measures real-time diesel engine soot particle mass emissions and performs characterization of average soot agglomerate size, number and surface area. SootTrak provides researchers and engine developers the accurate information they require about particle transport. With measurement accuracy of 5% using a known calibration source, SootTrak also sets itself apart from other real-time soot mass measurement techniques with its rangeability, application flexibility and resolution. SootTrak measures real-time soot particle mass emissions concentrations from 1 – 106µg/m³ for mean agglomerate sizes ranging from 50 - 500nm at data rates up to 10 Hz. Obtaining ±1 µg/m³ detectability requires 0.1 seconds of measurement time giving SootTrak the best sensitivity and resolution available.

With five years of development and patents pending combined with field-proven results, Sierra-CP was the first company to introduce the new and innovative SootTrak laser scattering by two axis ratio technology to the engine and vehicle testing industry. SootTrak measures real time soot mass emissions, particle size and number and is positioned in-line with a gravimetric filter holder to assure the highest possible data quality. SootTrak is available as a plug-and-play version for Sierra's Model BG3 partial flow dilution system. Future versions will be stand-alone for integration with other types of dilution systems such as CVS or other brands of partial flow sampling systems.

SootTrak measurements are based on first principles similar to gravimetric, optical absorption, and mobility methods, giving comparable mass and size accuracies without calibration. SootTrak can also be used for correlation to gravimetric PM filter measurements, soot modelling, PM filter cross-checking, as well as determination of soot number limits. SootTrak has a dilution ratio rangeability exceeding 50:1 when operated with the BG3, which is capable of sampling PM from any engine regardless of horsepower, fuel, and PM concentrations. SootTrak is housed inside a portable, height-adjustable cabinet that includes the sample extraction vacuum source and 1065 compliant temperature control. A microprocessor measures temperature and pressure automatically to convert to STP conditions. The instrument includes features for remote operation and includes user-friendly software that is unmatched in the industry.

BENEFITS AND FEATURES

- Accuracy: ±5% error
- Repeatability: ±3% of reading
- Wide Measurement Range of 1 - 106 µg/m³
- Minimum Detection Limit: ~ 0.5 µg/m³
- Fast Response Time: < 0.1 sec
- Plug and Play with the Model BG3
- Continuous Real-Time Soot Curve
- High Sensitivity for Future Regs (Tier 5, EURO 5, 2012 & later)
- Correlation to Gravimetric Measurements
- PM Filter Cross-Checking
- Soot Modelling
- Soot Number Limits
- Unlimited Dilution Ratio Rangeability
- Portable compact size
- Simple and fast calibration with ambient clean air

- Correlation to Gravimetric Filter Measurements - A fundamental model (patent pending) is used to relate the fast and sensitive optical scattering measurements of SootTrak to equivalent mass concentration measurements at EPA-defined partial dilution conditions provided by the BG3. Concentration measurements agree with gravimetric filter results (see Correlation Testing section).
- PM Filter Cross-Checking - SootTrak gives the user the ability to cross-check gravimetric PM filter measurements of concentration. SootTrak is incorporated with the BG3 sampled emissions flow stream, operating at the EPA-required temperature of 47C just prior to the filter sample. The uncertainty of PM gravimetric results after DPF and partial dilution is in the range of ± 30 -50%. (Kittleson, et al., AST, October 2009). SootTrak can help identify consistency of engine test cycle conditions in real time, saving valuable test cell time, and can help identify errant filter measurements following the measurements.
- Soot Modelling with SootTrak - When building a soot model, the engine is run through hours of operating conditions where engineers adjust a wide range of combustion parameters. Acquisition of detailed gravimetric filter samples at each mode is time-consuming and costly. With the BG3, SootTrak can rapidly and continuously build a detailed and accurate map of engine soot production.
- Soot Number Limits - Upcoming European regulations will require soot number limits along with standard gravimetric sampling. In addition, the California Air Resources Board is moving towards soot number limits as well, and the EPA will follow. Unlike other systems that only provide soot number or mass, SootTrak gives total mass, agglomerate size, and primary particle number, for carbon PM >30nm.
- Unlimited Dilution Ratio Rangeability - When SootTrak is run in tandem with the BG3, the user can set any dilution ratio desired well over 50:1 through the BG3 user software. The BG3 is capable of sampling PM from any engine regardless of horsepower, fuel, and PM concentrations.
- Measurement Range - SootTrak has a wide soot concentration measurement range of 1 – 106 $\mu\text{g}/\text{m}^3$, providing a flexible instrument for an array of applications.

APPLICATIONS

- For any engine size and fuel
- Steady state, ramp modal and transient test cycles
- On engine and chassis dynamometer test beds
- Measurement upstream and downstream of particulate filters
- Research & development

SYSTEM DESCRIPTION

While there are other scattering techniques, the SootTrak method is unique in calculating soot concentration from first principles (patent pending), without the need for gravimetric calibration. SootTrak operates at near ambient pressure to prevent evaporation of volatile and semi-volatile particles, and it requires no consumables.

SootTrak measures soot particle mass emissions concentrations from 1 – 106 $\mu\text{g}/\text{m}^3$ for mean agglomerate geometric sizes ranging from 50 - 500nm at data rates up to 10 Hz. When interfaced with Sierra's Model BG3, SootTrak is able to provide accurate measurements for all transient test cycles. Obtaining $\pm 1 \mu\text{g}/\text{m}^3$ detectability requires 0.1 seconds of measurement time, giving SootTrak the best resolution available.

Engineers can study the dynamic behaviour of particle emissions that occur during transient test cycles. An example includes the first few seconds of a cold start, or during regeneration of a particle trap or diesel particulate filter (DPF). In addition, SootTrak gives the user the ability to cross-check gravimetric PM filter weights (immediate analysis of test particulates prior to the filter weight measurement) and is also an exceptional soot modelling tool. Because SootTrak is a sensitive measuring method, it uses ambient clean air Rayleigh scattering to confirm instrument accuracy in less than a minute prior to each measurement sequence.



Innovate to Differentiate.



BG3 Particulate Sampling Support Equipment

Issue 4.1

INTRODUCTION

Sierra CP manufactures a complete offering of gravimetric particulate filter sampling and post-processing solutions to complement our BG3 Partial Flow Dilution technology. Our filter processing solutions assure that this critical final step of weighing the filter is done with precise accuracy. It is said that 50% of data variability is explained by poor post sample filter processing. Our goal is to drastically reduce the effect of poor post filter processing procedures.

HEATPAK – FILTER SAMPLING TEMPERATURE CONTROL

Our HeatPak is a particulate sampling temperature control package built to meet the US EPA 40CFR Part 1065 regulation. The HeatPak takes the diluted exhaust sample through a cyclonic separator, and controls the temperature and residence time to the filter face. HeatPak is plug-and-play with the BG3. The system can also be used in a manual mode with other devices.

Benefits and Features

- Meets EPA 1065 Regulation
- Plug and play control and verification by the BG3
- Can be used in manual mode with other devices
- Can be placed within the customer test cell and close to the exhaust stack
- Can also be adapted to any filter multi-changer like Sierra's Automatic Filter Changer
- Maintains the 47 degrees C within +/- 2 degrees C



FILTER HOLDERS



Sierra CP stock 47mm, 70mm, and 90mm filter holders, as well as filter media for use in particulate testing. All filter holders are made of 316L Stainless Steel and meet requirements set forth in the Federal Register.

Filter element cartridges are available in 47mm and 70mm sizes. Cartridges are designed to fit into an individual 47mm and 70mm filter holder or into our Automatic Filter Changer designed for 47mm and 70mm platters. The cartridges meet the material set forth by EPA.

Cartridge separators as shown, are also available to eliminate damage to the filter holder and media.



FILTER WEIGH CHAMBERS

After a high quality gravimetric sample is made by BG3, it is extremely important to assure high quality post-processing procedures. Up to 50% of any error in data can be attributed to these extremely important procedures. Our filter post-processing weigh chamber is a compact, complete, ready-to-run package that allows sample filter media to be accurately weighed per regulatory requirements. Add the Filter Bar Coding/Scanner option to get even more control over your filter media.

Our weigh station is a dual chamber "Glove Box" style design that allows the operator to stabilize and accurately weigh sample filter media from any size engine. A precision balance, such as the Sartorius, is supplied by Sierra-CP as an option.



AIRPAK – AIR SCRUBBING



Sierra CP's AirPak™ is an air handling and scrubbing system designed to clean compressor air (used for dilution air in the BG3) before it enters the BG3 system. The AirPak system can also be used for other analytical equipment within the test laboratory. Even though the BG3 has an adequate air purifying system on-board it has been found that many test facilities require this added measure of purification and protection.

The international standard for compressed air quality provides a simple system of classification for the three main contaminants present in any compressed air system: dirt, water and oil. We will work with you to specify the air quality class you require for a particular application and build an Air-Pack system to suit your needs.

AUTOMATIC FILTER CHANGER

Our Automatic Filter Changer is a plug-and-play cartridge-style device that allows the engineer to complete several tests in succession. It works seamlessly with BG3 Partial Flow Dilution technology to fully automate particulate collection to greatly improve testing efficiency and more importantly, testing safety. The system can hold up to 22 single filter cartridges (dependent on filter size, 47mm, 70mm, or 90mm). Sierra will customize the filter changer for 47mm, 70mm or 90mm applications. For example, Sierra has designed the changer to work interchangeably with both 47mm and 70mm.

Benefits and Features

- Compact Portable Cabinet
- Covered Flow Compartment
- Adjustable height stand
- PLC based Control System
- Host Control System Interface
- Interfaces to Sierra BG®2 or BG®3
- Partial Flow Samplers
- Positive leak tight seal
- Simple Test Set Up
- Converts from 70 mm to 47 mm filters in less than 10 minutes
- Connects within inches of the exhaust stack
- Optional Cabinet Designs
- Optional temperature controlled cabinet
- Optional heated sample inlet tube



System Description

- Filter sizes- 47mm, 70 mm & 90mm
- Capacity- 12 x 70mm 16 x 47mm
- Cassette– single or double 47mm and 70mm
- Leak tight at 29" Hg
- Cycle Time– approximately 25 seconds between stations
- Changer Dimensions–W 18"x D23"x H(adjustable) 20" to 35"
- Changer Weight– 40 lbs
- Controller Dimensions–W 19" x D 20" x H 5.5"(3U)
- Controller weight 15 lbs
- Minimum expected operations>100,000 cycles
- Utilities– Clean Compressed air at 90 psi (610kpa)
- Power– 120, 200,240VAC50/60 Hz
- Remote control cable– 25'
- Meets Federal Register Requirements
- Built in parallel control computer interface
- Standard 19" rack mount chassis
- PLC based control Functions: Advance - Rotates carousel to next position / Home - Rotates carousel to start/home position
- Status Indicators: Power, Sampling / Cassette cover on/off / Sampling cone up/down / Exhaust cone up/down

CONSTANT VOLUME SAMPLER UPGRADE

The Constant Volume Sampler (CVS) systems have been an accepted method for measuring both gaseous and particulates for engine manufacturers for many years. Over that time, specifications for the CVS systems have changed significantly.

Sierra CP Engineering Automotive Test Group has identified the need to upgrade older CVS systems to meet the current specifications and requirements for both chassis and engine dynamometer testing. Most CVS systems may be upgraded to current regulations at a modest cost at a customer site or at a Sierra CP Engineering site.

Benefits and Features

- System upgraded to meet current regulations.
- Current flow of system can be modified for different fuels or usage.
- System upgraded at a fraction of the cost of a new CVS system.
- Customer staff will retain the knowledge of their current system, thereby reducing training required.
- Automated with current control software and hardware.

GLOBAL LOCATIONS



Manufacturing & Support Centers in USA / UK / CHINA / INDIA / MALAYSIA



SIERRA[®]
CP ENGINEERING

www.sierra-cp.com